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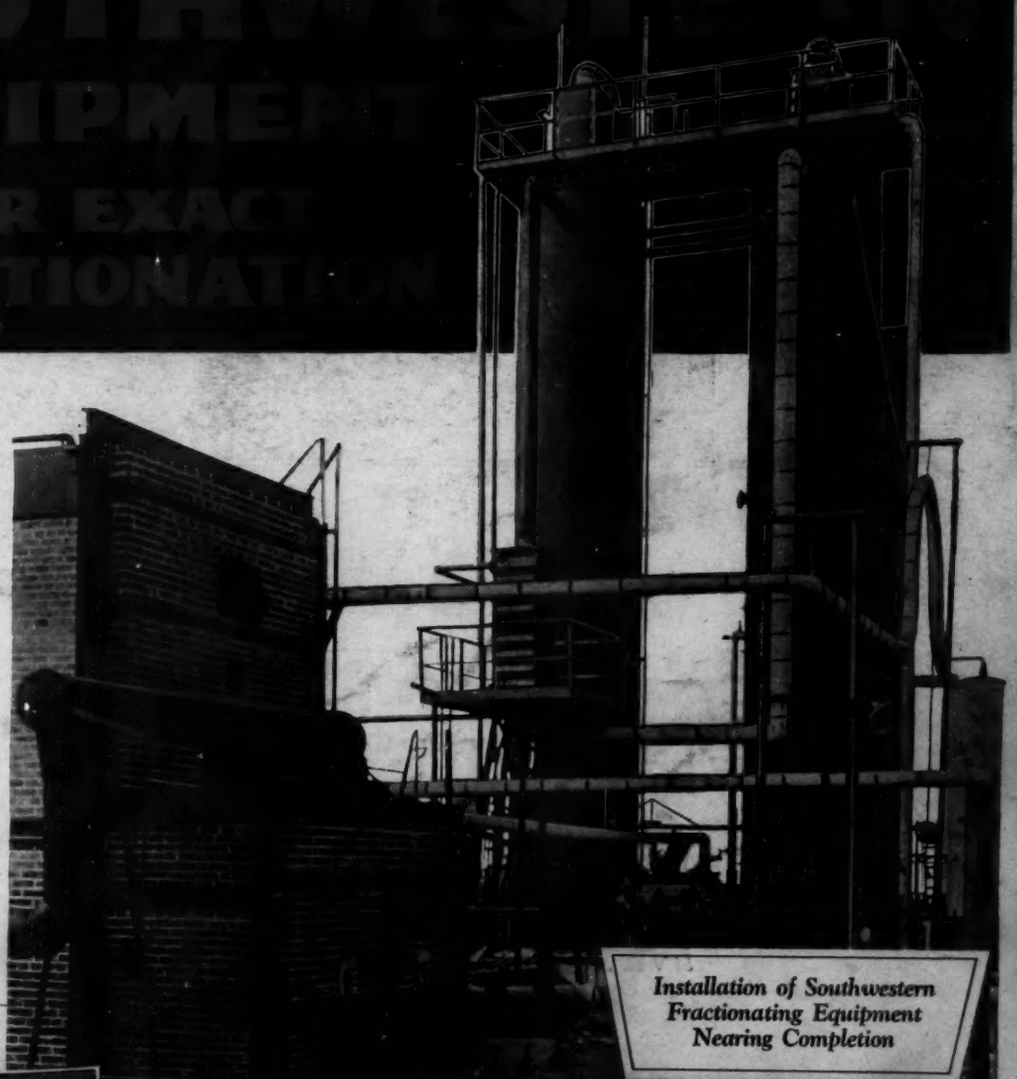

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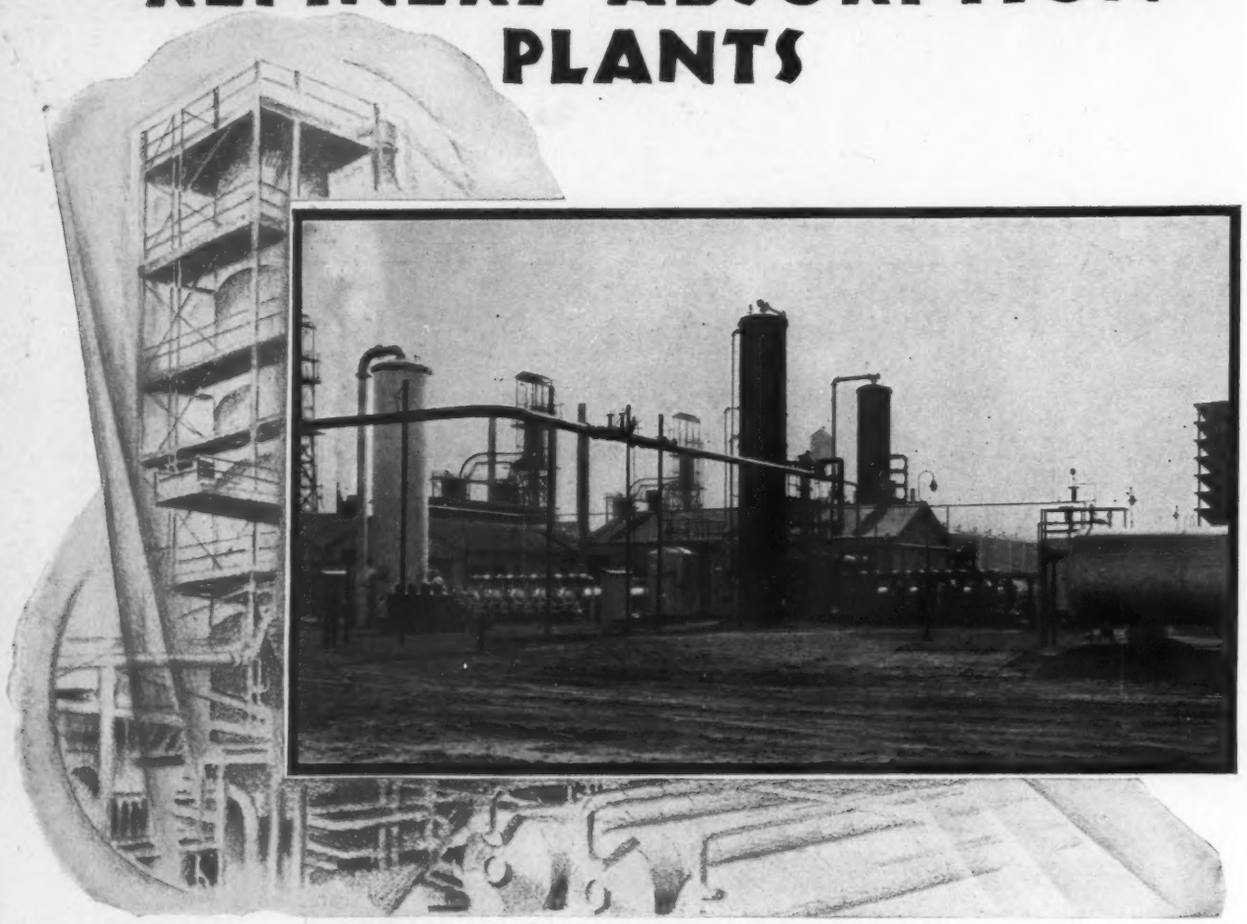

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The REFINER

AND NATURAL GASOLINE MANUFACTURER

Edited Monthly at Tulsa, Oklahoma

GRADY TRIPLETT, *Editor* GEORGE REID, *Associate Editor*

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A HUNDRED feet above the Harlem River, a line of Wrought Iron Pipe has been carrying 90,000,000 gallons of water daily to the population of New York City, *since 1861*. Recent changes in the design of High Bridge, to accommodate increasing navigation, uncovered the pipe which had to be taken down so that the work could be done. After close inspection the pipe was proclaimed in perfect condition and fit for use again. It is being put back in its old place and will undoubtedly keep on serving as long as the bridge which supports it.

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Mention Where You Saw the Advertisement

Keep It Black

AT last black ink is being used on books, which for several months have been yielding to the distress color in bookkeeping. These are the ledgers of refining concerns in the Mid-Continent. Present prices allow profit. Two conditions came to mind when considering this change.

The first is of lesser consequence. But it is interesting to consider how quickly the economics of the refining industry change. One day, a refinery does its work at a loss. The next morning sees profit. Converting crude oil into marketable merchandise is a fickle endeavor.

The second recation to present conditions is a question of greater consequence—how long will the making of gasoline continue to be profitable?

This is no effort to class present profit as satisfactory. There may be refining concerns not yet showing profit. Certainly none has in the past month made a profit to match its losses for six months previous. All the present condition promises is a change of desirable complexion.

As for how long it will continue, so much depends on the actions of men that it is but natural to raise a warning.

It is possible for men to assure continued profit for a year or ten years. It is not probable, however, that the men responsible for policies will so conduct their respective activities that profit will continue for that long. History has a contrary record.

Continued profit is an ideal. It is not within hope, for economic conditions are never static and human decisions are not proper in each instance.

But so much depends on how economic conditions are treated that is possible for men to control profit. No man can determine what set of conditions he will face. He can not marshal economic change. He can not forecast weather. He can not foretell the actions of other men.

All these weave a cloth which each man must accept as his field. In this case, these forces present the field of sales for petroleum. While no man in the refining business can weave this cloth, he can determine how he will accept the weave of loom.

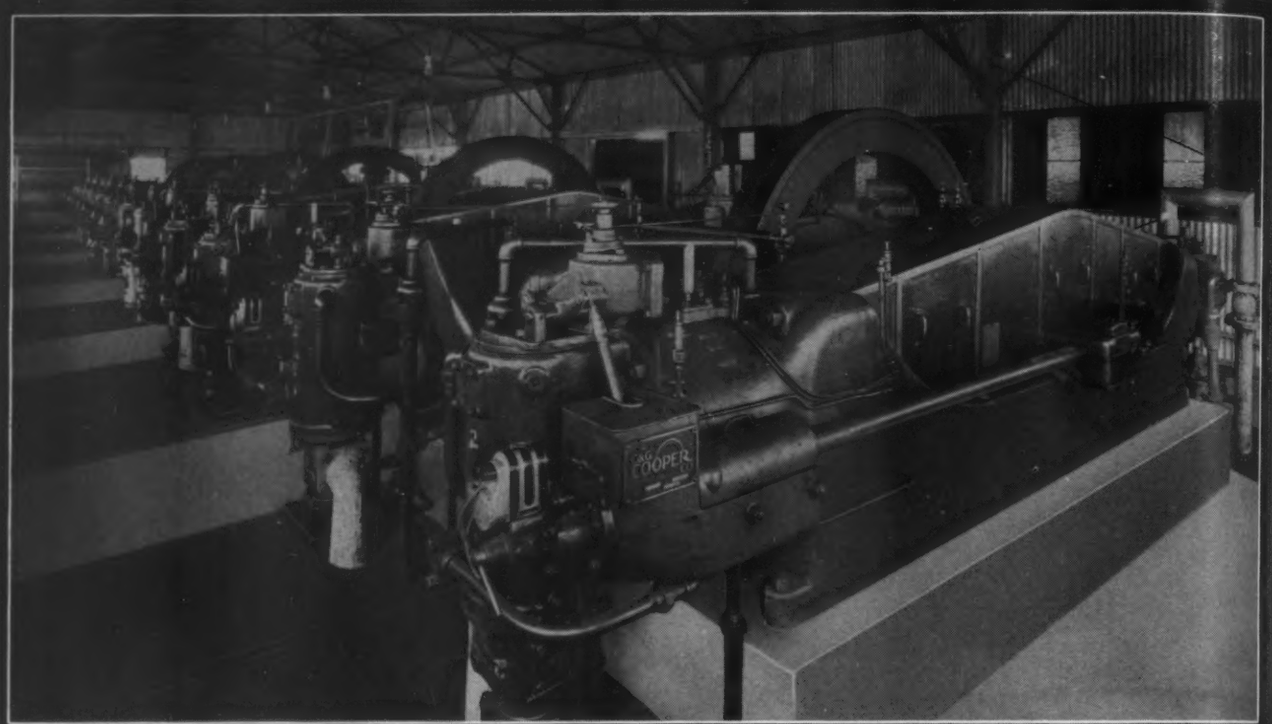
The maker of gasoline can not determine the conditions under which his product must be sold. But he can determine how he will accept those conditions. He can dictate the terms under which he accepts the conditions.

He can select to make gasoline without regard to its need or the price it will bring him. The record of the past year is evidence that some refiners will keep their stills pouring out gasoline which must move into a saturated market at a loss.

Or a man can determine that he will sell only at profit. This may require idle equipment, the loss of crude contracts and the loss of valuable employes. But it is within the scope of normal business authority to cling to such actions.

Between these two are numberless other decisions, each of which will have some bearing on what profit the refining of petroleum claims in the future. This business of making gasoline needs black figures for months and months. Each man in an executive capacity in refining will by his decisions contribute something to how long the black ink is used on refiners' books.

Grady Tribbett



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A field superintendent was asked "What gas engine would you recommend for a three-engine booster station?"

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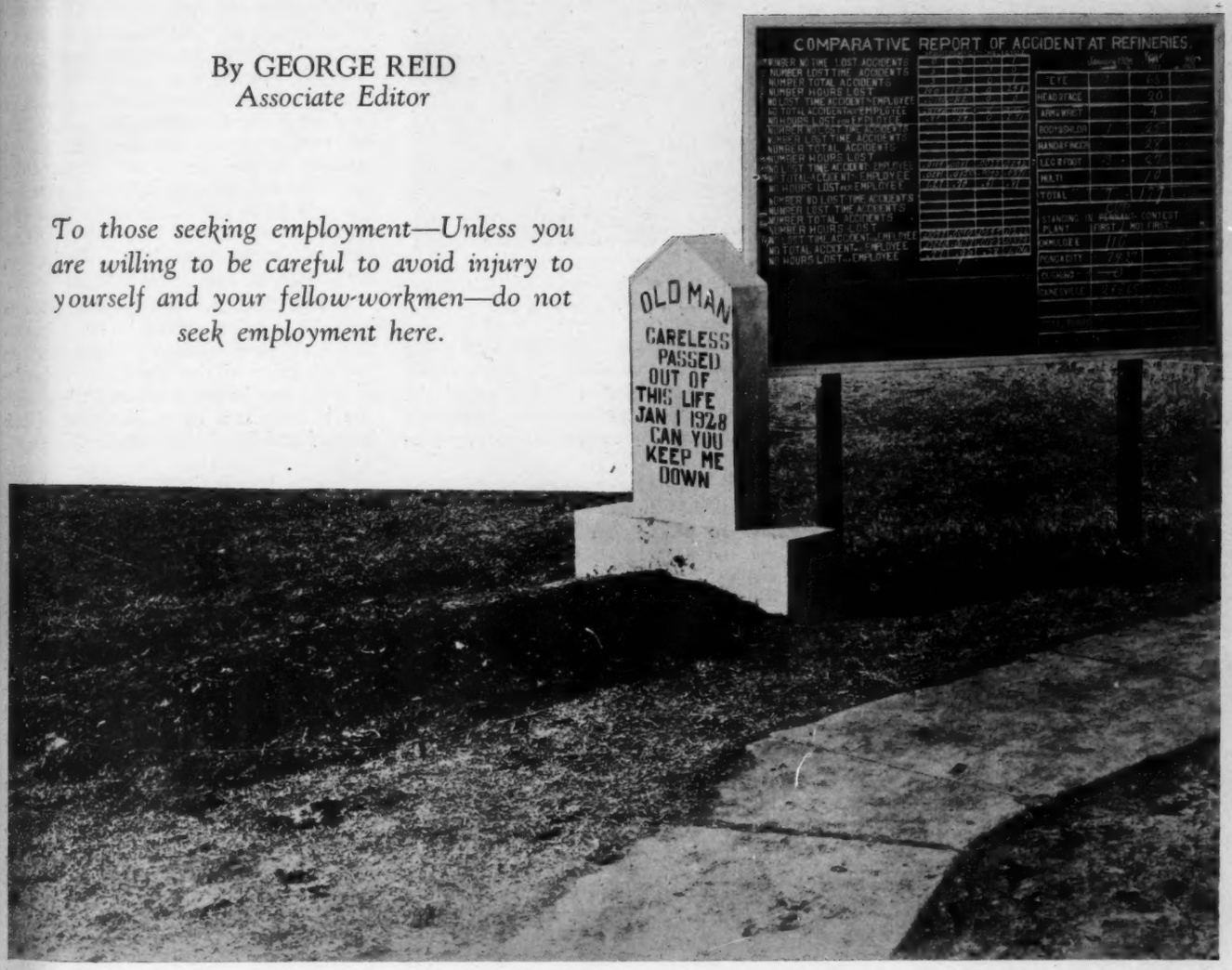
Old Man Carelessness Lies Moulding In the Ground

By GEORGE REID
Associate Editor

To those seeking employment—Unless you are willing to be careful to avoid injury to yourself and your fellow-workmen—do not seek employment here.



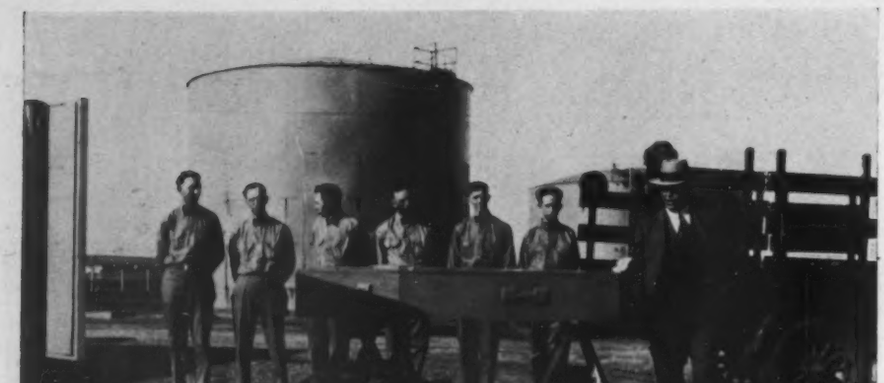
THE above sign, placed at the entrance gate at the Cushing, Oklahoma, refinery of Empire Refineries, Inc., (Cities Service Co.), by the Safety Committee is a commendable and forceful means of telling the new employes that carelessness will not be tolerated.

Concerted effort on the part of executives, officers and the large number of employes comprising the organization which operates Empire's Cushing, Okmulgee, Ponca City, Oklahoma, and Gainesville, Texas, refineries, over the past two years has resulted in the perfection of a Welfare and Safety First program which is securing enviable results. The safety policies are paying dividends. Because of the enthusiastic co-operation of all employes on the Empire payroll, these policies will continue to pay dividends. Those in charge of the work were early to recognize the fact that no safety program can succeed unless the foreman and the men working with these foremen are enthusiastically interested. Thus the early work in advancing the company's safety and welfare program was that of securing the co-operation of the foremen in the organization. Since foremanship involves the training of men, in conjunction with the other duties of the office, it was but a matter of little time until the operating personnel of the four refineries was also a "safety first" personnel.

The details of the safety first and welfare program of Empire Refineries, Inc., are handled by E. B. Kirshner, under the supervision of W. H. Camp, general superintendent of refineries. At the plants the safety committee consists of the refinery superintendent and all of the foremen, with one man at each plant in charge of the details of the safety program, who might well be called plant safety engineer.

The four refineries mentioned are in constant competition with one another for the winning of a beautiful silver cup which the company gives the plant which shows the best performance over a period of six months. The plant name is engraved on the cup at the end of each period and when one plant wins the cup three times, and has its name inscribed upon it that number of times, that plant keeps the cup permanently and a new cup is started. Four factors contribute to the winning of this prize, as follows: Hours lost, total number of accidents, increase or decrease in accidents during the six-months' period and the the increase or decrease in hours lost during the period. At the end of the first six months of 1927, the Cushing refinery was winner of the prize. During the latter half of 1927, Cushing and Ponca City ran "neck-and-neck" for some time, with the Ponca City plant finally nosing out a slight few points ahead in the race, and the cup changed hands.

This competitive spirit has resulted in the enthusiastic support of the safety pro-



The first-aid team of the Cushing plant, as pall bearers at the burial of Old Man Carelessness. Superintendent, C. O. Bailey, sees that it's well done.

gram throughout the entire organization. Figures from last year's reports covering all four refineries show that the average lost time for that year was 81/100 hours per man per month, which was considerably lower than the records for 1926. The average for all four plants in 1927 shows but .0232 accidents per man per month, or 2.3 accidents per 100 employes. There were no fatalities during 1927. As a further indication of how safety pays, the hours lost time during 1927 decreased 19,000 hours during the 12-month period. From the viewpoint of the workmen alone that decrease in hours lost, secured by his endorsement of the safety program, figured at an average of 50 cents per hour, represents a total of $9,500 saved through being careful.

While it is admittedly difficult to measure the numbers of beneficial results to either employe or company organization, the safety program with the Empire organization has resulted directly in a marked betterment of morals and a greatly decreased accident rate. The indirect results, as well as the direct effects of any one accident may be far reaching, thus the primary purpose of the safety campaign is the training of the individual employe to use every precaution in going about his daily routine. The experience of this organization is indicative of the dividends, both tangible and intangible, which are paid by co-operative safety programs.

Old Man Carelessness is Gone

When the Ponca City refining crew nosed out slightly ahead of the Cushing plant and took away the silver cup, then the Cushing organization held a mass meeting of all employes to discuss ways and means of retrieving the lost prize. At this meeting Superintendent C. O. Bailey suggested the signing of the pledge which stated, in effect, that each member at that refinery personally would do all in his power to sustain the high record of the plant and would continue to work carefully. Discussion brought out that carelessness was the major cause of all accidents, upon which all those present agreed. Subsequent discussion from the men brought up the suggestion that "Old Man Carelessness" be interred deep under the sod—since there was to be no more carelessness at that plant.

The suggestion resulted in the building of a coffin for the "Old Man Carelessness," then the digging of the grave, and the burial of this gentleman in effigy. A local minister attended the burial and conducted the ceremony of interment. Superintendent Bailey addressed the crew, the safety committee headed by O. A. Mann, assistant to Mr. Bailey, and the first aid team, along with the rest of the organization, renewed their pledge to tack up a safety first performance which would retrieve their lost cup, and then keep it.

The burial of "Old Man Carelessness" had, and still has, its psychological effect, for each time the men enter or leave the plant yard they must pass the grave and head stone marking the place where they left behind all carelessness. The boys at Cushing decided that if it took a perfect score—no accidents, and thus no time lost—to get back the silver cup, then they would report that kind of score. At the time of the writer's visit, early in May, the score was still perfect.

A trip through the Cushing plant to inspect safety measures is very instructive, and these measures, along with the perfect score of the plant, are indicative of what can be accomplished when every one is interested in the welfare of both himself and his fellow worker.

Number of signs of this type are placed about the plant, bearing pertinent messages of safety first.

Mechanical Devices

Stairways leading to the top of condenser boxes, platforms and across these boxes to all parts of the equipment where men must go for inspection or labor, are constructed of Irving subway tread for stairs and platforms, with double guard or hand rails. One guard railing is not sufficient, for a man may slip through below the single rail to experience a bad fall, or to drop into the water in the boxes.

The double rail is in accordance with Oklahoma State specifications. "Toe rails" extend above the tread for two inches, so that in the event a foot slips, the fall will be broken by this guard. Permanent metal walkways are installed around the tops of all vapor fractionating columns, which are of the same type as the walkways above the condenser boxes. On the ground, wherever men must walk over lines laid above ground, the same metal tread is placed. Vacuum and pressure relief valves, with which all stills are equipped, are extended by nipples and els so that in the event of any discharge of vapors from the still, etc., these hot gases are blown into the water in the condenser boxes. The valves are subjected to frequent inspection to assure their good working conditions.

Behind the still batteries signs are placed which read, "Fires can be prevented"—for it is recognized that this part of the refinery is the most hazardous from the standpoint of possible flashes. Other signs placed there, where certain lines are above ground, as in every refinery, which are sometimes very hot, which read "Watch your step—hot oil lines." Thus the workman is reminded not to step on or lean against hot lines or valves in this part of the plant.

A plant yard roadway leads under the run down lines from receiving house to tanks. Large signs are placed on each

side of these overhead lines which read, "Not room for man standing on truck."

Over at the agitators there is an innovation in safety practices. A sign reading, "Wear your goggles while working around agitator equipment" implies the danger of possible breaks or leaks, in acid and alkali flow lines. The company furnishes the goggles to the treater, and it is only necessary for him to wear them while engaged in the treating of oils. Still further precautions are exercised in the treating department, in that the treater is supplied with an extra asbestos helmet which he must wear to the top of the agitators whenever sampling or gauging the filled equipment. The helmet is an additional one, or extra, coming with the Johns-Manville asbestos suit which the plant keeps on hand for use in the event of certain types of fires where such suits may be used. The treaters helmet has once been the means of saving a man's face and eyes from possible severe burns, and that one flash, some months ago, has shown the men that the wearing of the helmet is of value.

Timely Warnings

"Do not change belt while machine is in motion." This sign greets the workman at every machine in the shop—and has the additional effect of telling him that all these machines are dangerous. In the boiler house, among other pertinent messages, there is one large sign placed up above the boilers. It can not be seen except by the boiler-man when he climbs on top to work and inspect. It reads, "Warning—do not step on boiler arches." These arches are flat, but flat or arched, the danger is obvious.

Much pumping and transferring is done at the Cushing plant with electric power. Pumps have individual switches—and signs at the switch boxes read, "If you do not know how to work switches—leave them alone." On the concrete floors and in front of each switch a large rubber mat, one-fourth-inch thick is provided to act as an insulator, in the event of shorts, etc.

In the pump houses such placards as "Make sure your valve line-up is right," remind those handling the pumps that costly errors can be made by the simple turning of a single valve wheel. Great care must be exercised in the pump houses to avoid errors in transferring. One small placard which the writer noticed at this pump house, not standardized like all the others, and probably placed there by some other than the safety committee, pertinently inquires, "Are you working to get by, or to get ahead?"

Out on the loading rack which is of steel pipe supporting framework, with heavy wooden platform, and guarded its entire length by double guard rails, a number of signs are placed at various points which are of interest. Among them are:

Think—are all valves closed.

Think—are all run boards in clear.

Think—are all spouts in the clear.

There has not been a spading spout jerked from this rack in years. Leaks and spills are almost unique, and the walkways are kept clear of the usual loading rack "clutter"—and the records of the plant show that the men work carefully.

The whole crew helps cover the coffin with earth, when the Cushing plant buried Old Man Carelessness.

All run-down tanks are equipped with steam "smother" lines. These lines are two-inch, and at the point of entry into each tank they are looped to provide for expansion when in use. The loop is an economical expansion joint. Without such precautions such steam lines often pull loose and when the time comes for their use, much of the steam which is meant for the blaze is released to the air. At the Empire plant the safety crew inspects and tests the steam lines regularly every two weeks and assures themselves that if they are needed they will be in the proper condition. In addition, adequate fire fighting equipment is provided on the plant and at strategic points for the quick extinguishing of any flashes about the plant yard.

Men are not permitted to enter any tank car for cleaning purposes or repair unless wearing a mask suitable for the purpose.

As part of the safety first equipment the company keeps on hand a Mines Safety Appliance hose mask, with 50 feet of hose, for use when going into any gaseous container. The usual well equipped first aid kit is always accessible. As part of the first aid and safety work, 14 men on the plant payroll have certificates of training in first aid work, and the first aid team is kept busily engaged in training all of the other employes at the plant.

This describes something of the safety work and the program in force at Empire's Cushing refinery. The outline covers practically every feature in force at the other company plants at Ponca City and Okmulgee, in Oklahoma, and at the Gainesville plant, in Texas. Ideas originating at any refinery are passed on to all of the others and applied to similar conditions where possible. The finest feature of the program, however, is the enthusiastic co-operation of the men, and the wholesome spirit of competition among the plants, which are, in fact, the essential qualities for successful, dividend paying, safety first work. The sign at the front gate of the Cushing plant, with which this discussion was opened, and the grave of "Old Man Carelessness" also at the front gate, are excellent "reminders," that this plant must be kept safe for the workman and his fellow workers.

Here the crew of the refinery are listening to no eulogy,—Old Man Carelessness is getting his just deserts.

Treating Plant Emulsions—Some Theory and Practice

By L. J. CATLIN
The Standard Oil Company (Kansas)

IT would perhaps be safe to say that no single problem of the treating plant operator is quite so exasperating as emulsions when they occur. And it might also be said that there is perhaps no better illustration of the possibilities of co-operation between laboratory and operating department than in solving some of these emulsion problems; for emulsions are like horses, in that no two of them are exactly alike. However, in at least one very important respect they differ from horses in that for the years immediately ahead the number of them is likely to be on the increase; perhaps in about the same ratio that the number of horses decreases. They are as whimsical and inexplicable as the weather, and it is no wonder that after exhausting all other probable theories a man is sometimes driven to the conclusion that they are caused by "atmospheric conditions." And when Gabriel finally lets us in on the "real dope" that may not be so far from the truth, because the colloid chemist has already furnished a logical explanation for a great many peculiar things on the basis of electrical charges.

And now we have made a fatal blunder, by using a word that has to be defined, and since this paper is attempting to deal with co-operation between laboratory and treating plant, our definition must attempt to satisfy both views of the question. That fatal word is "Colloid."

We can readily agree upon a few more common terms, such as soluble and insoluble; solution and precipitate. We know that we can add litharge (lead oxide) to caustic soda solution and the final result is lead in solution. We also know that after treating sour oil by a successfully completed reaction we get a black, insoluble, precipitate of lead called lead sulphide. The lead has passed through a series of chemical and physical changes, beginning as a fine powder, then gradually, by the action of the caustic, being disintegrated into finer and finer particles till it disappears from view and becomes seemingly a part of the liquid, even to the extent of passing through filter paper with the liquid, and being equally distributed throughout the liquid. After the chemical change which converts this lead to the sulphide, which is insoluble in the caustic, we may think of these extremely small particles as collecting together into larger and larger groups till we have particles large enough to overcome the resistance to falling offered by the liquid, and they settle to the bottom. They will not do so at once, however, because being formed in the oil, they are of course wet with oil and the oil film surrounding each particle acts as a floater till the particle finally breaks through the film and gets into the caustic, or water portion. It can be readily seen that if this oil film is a low-boiling distillate it may be easily broken by heat sufficient to start vaporization of the oil.

In the Good Old Days

In the good old days of straight-run gasoline, and sweet crude, the above description would about tell the tale; there was no trouble separating the treating reagents from the oil, and no troublesome chemist meddling with the affairs of the man at the agitator; and now see what we have, and still we call it "progress:" precipitates that won't settle; emulsions that won't break; and chemists that won't stay in the laboratory. Anyway, on Sunday there are sure to be plenty of filling stations operating to keep the old flivver going a good many miles in a straight line away from all this mess, and leave time for a few hours of peaceful (?) slumbers before the "morning after."

Still we haven't disposed of that troublesome "colloid" and we can't dodge the issue much longer. As a starter let us say that a colloid is a very small particle of any substance, which in size is intermediate between that found in the substance when in solution, and when it will precipitate, or settle rapidly. It is not a certain chemical substance, but a particular physical state which may be brought about in any substance.

A few illustrations will make it more clear. A clod of dirt thrown into the air falls at once. The same clod pulverized to dust will settle more slowly because of the resistance of the air; we might call it a precipitate. The same dust if picked up by an Oklahoma "southwester," a Texas "norther," or a Kansas "cyclone," may be whipped and thrashed into particles so fine that they float in the air for days, even after the wind dies down, causing haze, rosy sunsets, etc. It is then said to be in a colloidal state. If there were such a thing as dust going into solution in air it would be still finer than the colloid, and the air would be clear and transparent again. Water in air gives a better illustration.

Rain is a precipitate, mist is near the colloidal state, while fog, steam and clouds are true colloids; water vapor, always present in air is a true solution. It is water in all cases but we may think of it as being merely in varying sizes of particles, and hence varying degrees of dispersion in the air. Colloids, then, are very small particles of any material scattered or dispersed through some other material or medium. We hasten to say that a colloid chemist is merely a chemist who studies colloids.

To bring our illustration back to the treating plant, doctor contains lead in a compound which is in solution—at least mainly so—on adding to sour oil which has the hydrogen sulphide already removed, it forms lead mercaptide which remains in the oil as a colloid, varying in color from green to reddish brown, till sulphur is added, when the reaction is completed to form lead sulphide, which usually settles as a precipitate. In this case the three physical states are also tokens of three different chemical compounds of lead. When a substance changes from a colloidal state to a precipitate we call it coagulation. It must be understood that there is no sharp line of demarcation between colloids and true solutions on the one hand, nor between colloids and precipitates on the other, but these rough classifications help discussion.

Emulsions are only one of many important applications of colloid chemistry. Technically speaking, the precipitate which fails to settle is not an emulsion but a suspensoid, and there are some important distinctions between them; however, we do not do much violence to our subject by including them here. In both cases we have a liquid with very fine particles of another substance suspended and dispersed through it. In the case of the emulsion the suspended particles are another liquid; in the case of the suspensoid they are suspended solids. In both cases we assume that there is a third factor, that is, something which prevents the fine particles from coming together in larger particles. In the case of the suspensoid that factor may be an electrical charge on the particles; in the emulsion we call it an "emulsifying agent." and it may be anything which can form a film around the suspended particles, making them act as though they were solids.

It very often happens that a mere statement of an elementary, or fundamental principle furnishes the cue, or we might say the loose end for straightening out a new tangle; and this is where the laboratory man should be of particular assistance to the man at the valves. A recent experience furnishes an illustration of this point, as well as what appears to be a general method for settling fine particles of lead sulphide from an oil.

Chasing the Colloid

Heavy distillates were being treated in agitators as finished stocks where color had to be maintained. These distillates contained some cracked stocks as well as a small percentage of distillate from "high sulphur" crudes, which may have been the cause of the trouble. After agitating with doctor, sulphur was added till the precipi-

tate of lead sulphide formed would filter out readily and the filtered sample test sweet. In the agitator the main portion of the precipitate settled readily, but there remained an extremely fine portion dispersed throughout the distillate which would not respond to further additions of sulphur, or water washing, and which required hours, and sometimes even a whole day for settling.

Testing these samples in the usual glass bottles and laboratory separatory funnels, it was frequently noticed that after shaking violently for some time this precipitate would be found adhering to the glass in a thin film and the oil could be poured out clear, while this film remained clinging to the glass like a skin. The obvious suggestion was an electrical charge. Every one is familiar with the elementary experiments with static electricity, and the fact that pith balls, or light particles of any kind, when charged with like charges, either positive or negative, will repel each other, and if suspended by threads will keep apart as far as their weight and the threads will permit. This seemed to be the condition which prevented these particles from coagulating, and made them spread like a film all over the inside of the glass bottle after shaking.

It was noted, however, that they did not collect on the glass till after shaking, which suggested an electrical charge on the glass due to agitation with oil, and now we had something which might be tested. A simple electroscope made out of an erlenmeyer flask, pieces of tissue paper, and fine copper wire (see illustration), furnished the necessary testing equipment, and a piece of sealing wax rubbed on a wool sweater (worn by the laboratory man) furnished negative electricity, while a piece of glass rubbed on a silk shirt (worn by the office boy) furnished the positive. In the experiment it seemed likely that the charge produced on glass by shaking with oil was opposite to that already on the suspended particles of lead sulphide, hence the attraction. With the electroscope charged first with negative and then with positive electricity it was now possible to test the charge produced on glass by oil, after first emptying the oil to dispose of the opposite charge. This charge on the glass was found to be positive, and by inference that on the lead sulphide particles was negative.

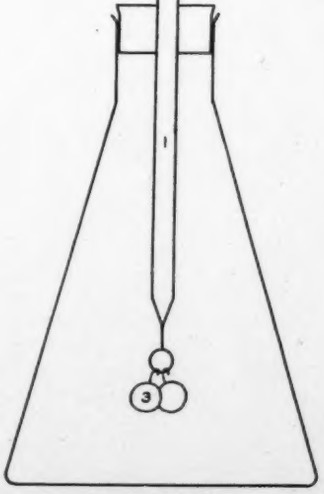
This, of course, was interesting, but not very practical, because no laboratory man, however unsophisticated, cares to suggest using static electricity around an agitator charged with distillate and blown with air. This is where the text book comes into the story. After wading through a volume on the special subject of colloid chemistry and learning how to make mayonnaise and insecticide emulsions, and even cream gravy, no brilliant gleam had yet penetrated the benighted dome of the laboratory man, when as a sort of easing off, he picked up a little college text which devotes one short chapter to colloids, and found the following simple statement of an elementary principle in colloid chemistry which turned the trick:

"Most kinds of suspensoid particles are negatively charged. But the particles in colloidal solutions of the metals and metallic hydroxides are usually positively charged."

It seemed evident both by test and by statement of the text, that our offending lead sulphide particles were negatively charged. Now if we could get a "colloidal solution of a metal" which had positively charged particles we might sneak some static electricity into our reaction without the superintendent finding it out, and better still, without any danger.

Lead in Doctor

It had previously been noticed while testing doctor solutions for lead that on adding sodium sulphide, or hydrogen sulphide, that after the main portion of the lead sulphide had settled it was necessary to boil the solution to get rid of the last bit of brown coloring, and get a clear filtrate, free from lead. Besides this, the chemists of Eagle-Picher Lead Company had furnished a method for determining lead in doctor by taking the color of a colloidal solution of lead sulphide, and in both of these cases the colloidal state seemed to come when there was a comparatively small portion of lead in a large volume of solution, or in other words, a dilute solution. Such a colloidal solution can be prepared in the following manner: About one part by volume of doctor solution is diluted with about 10 to 15 parts of water, and to this is added a very dilute solution of sodium sulphide. This gives a colloidal solution of lead sulphide, which should be a transparent brown free from visible particles. It should be prepared immediately before using because it soon starts coagulation and that portion is probably rendered useless. The proper proportions can be readily determined by trial. The statement of the text proves good in this case, because this collodial solution when added to the oil in which the fine particles of lead sulphide are suspended causes them to settle at once. All the details of handling have not been worked out, but a few precautions seem obvious, according to theory. The amount of this collodial solution added to the oil will vary according to the amount of suspensoid in the oil. In other words, the amount of positive lead sulphide colloid must equal the amount of negative colloid to give a neutral condition for settling. It might be possible to go too far and get positive particles suspended in the oil which would be as bad as the original.



ELECTROSCOPE
1-Nail
2-Ball of Solder
3-Loop Copper Wire, Covered Tissue Paper

The attractive features of the process are that it uses only materials which are already available at the treating plant; and nothing is added which will in any way injure or waste the doctor solution. The doctor solution should, of course, be drawn off as completely as possible before adding the colloid wash. Care should be taken not to add excessive amounts of sodium sulphide, and if desirable the clear portion of this wash may be drawn to the sewer while the precipitated lead sulphide may be drawn back to the doctor for restoring. Sodium sulphide will be available if caustic soda is used as a wash for removing hydrogen sulphide ahead of other treating reagents. Other important details will no doubt suggest themselves to chemists and treaters working together.

As already stated, it takes three things to make an emulsion, namely: two immiscible liquids, such as oil and water, and an emulsifying agent, which has the property of surrounding small droplets of one of the liquids like a skin or capsule. There are two general types of emulsions and it is often very important right at the beginning to determine which type we are working with. In one case the oil is broken up into droplets and dispersed through water as a medium, and in the other case the water is in the droplets, or capsules, and dispersed in the oil. The one which is dispersed is called the "disperse," or "internal" phase of the emulsion; and the other is called the "continuous," or "external" phase. The simplest test to determine which type we have is to see what takes place when we add more oil or more water. Whichever one mixes readily without changing the appearance of the emulsion is the external phase. Or suppose the emulsion sample is in a bottle and is poured out. If some of it sticks to the bottle, see whether it is more readily washed out by water or oil. The one which washes the bottle readily is the external phase.

The Emulsifying Agent

The emulsifying agent is usually not easy to identify and the amount of it may be very small compared to the amounts of liquids. Besides, any method for separating it from the oil usually destroys it or changes it. Still it has certain important relations to the emulsion which it is important to recognize. In the first place it is probably in most cases a colloid, that is, not completely soluble in either water or oil, and yet not sufficiently insoluble to precipitate, and hence tends to collect at the interface where oil and water come together. This may be an electrical phenomenon similar to that which caused the

lead sulphide to form as a film on the glass as previously described. In the second place this colloid material has a definite preference for one of the liquids, or is more readily wetted by one than the other, usually considered to be the external phase.

Some homely illustrations will help to show the place of the emulsifying agent. In making cream gravy the emulsifying agent (flour) is added to the oil (grease) and thoroughly mixed. Water is added, and heat swelling the starch grains forms colloidal films around the dispersed droplets of oil and an emulsion results. That water is the external phase is evident from the fact that more water can be added to increase the bulk of the emulsion, while if more grease is added it separates out on standing. Mayonnaise is an emulsion of oil in vinegar with pulverized egg yolk as the emulsifying agent.

At the treating plant, emulsions frequently occur in the doctor solutions which are of the type in which the oil is the disperse phase. In this case the emulsifying agent is probably lead mercaptide, which accumulates in the doctor and by continued circulation through mixing columns gathers droplets of oil till at last a thick emulsion is formed. The method of prevention is the use of more sulphur, or perhaps better distribution of the same amount of sulphur to more nearly approach continuous feed. Previous solution of the sulphur in oil permits continuous feeding of the sulphur as required. Completion of the mercaptan reaction to the formation of lead sulphide causes precipitation, and prevents the accumulation of colloidal lead mercaptide.

Once the emulsion is formed, however, the addition of sulphur fails to break it because of the low solubility of sulphur in the water, or doctor phase, through which it must pass to reach the mercaptide. It may be stated as a general principle that if we are to break an emulsion by chemical action on the emulsifying agent that our chemical should be something which is soluble, or miscible with the external phase. There are several ways of breaking this doctor emulsion, but only two will be discussed here because they both permit recovery of the doctor for future use. The first method has perhaps limited applicability but works well as a laboratory experiment, as follows: Add to the emulsion a strong solution (at least 30 Grav.) of caustic soda, in an amount equal to about one-third to one-half the bulk of the emulsion, and mix thoroughly. Now add about the same amount of water and stir gently. The emulsion usually breaks at once.

The second method is applicable where lead sulphide precipitates are saved either for sale or restoring, and where caustic solutions are used for washing out hydrogen sulphide, carbon dioxide, etc., or for neutralizing acid in sludge emulsions, as described later, and are salvaged from the doctor for that purpose. The method depends upon the breaking of the lead mercaptide film by precipitating the lead with sodium sulphide, or hydrogen sulphide. Spent caustic from the H_2S wash is added to the emulsion and heat applied till the oil and caustic separate readily and the lead sulphide formed settles readily to the bottom. The oil is skimmed off, the caustic pumped out, and the lead sulphide sold as such, or restored by air blowing while heating with fresh caustic. This method may also be used for salvaging lead from doctor solutions which have turned red from restoring with air, till no longer fit for use on finished stocks. The caustic is used as described before.

Water in Oil Type

Acid sludge emulsions furnish a good example of the "water in oil" type. Crude oil emulsions are also usually of this type. When an acid sludge is washed with water some oil may collect at the top, and dilute acid at the bottom, with a layer of emulsion between, which varies in appearance from a heavy pitch to a thin mud, depending upon the kind of stock treated, etc. The dispersed water, of course, contains acid of about the same strength as that which settles out and represents that much loss in recovery. Here again the method of first adding concentrated acid and then diluting with water can be used, but in most cases it is doubtful if the acid thus recovered equals the cost of reconcentrating the fresh acid added. A method for breaking this emulsion without destroying the acid would be very desirable. There is a method which destroys the acid, and since it is a loss anyway, it is still an advantage because it permits the recovery of oil for fuel and does away with the worst sewage nuisance about the refinery. Solutions of caustic soda or soda ash are used for neutralizing the acid, and spent solutions from the treating plant seem to be even better than fresh solutions. Great care must be taken not to use solutions containing sulphides in open separators, because of the generation of H_2S and consequent danger to operators. These might be used in closed vessels where the gas generated could be conducted to a furnace and burned, but it is exceedingly hard to carry out this neutralization in closed vessels because they must be watched and tested carefully for the neutral point. If excess of caustic is added the emulsion is reversed and just as obstinate as before. A general description of the method may be given as follows: The emulsion is collected in the regular separators used for washing acid sludge. It should be allowed to stand for about 24 hours while heating with a closed steam coil in order to settle as much as possible of the acid. After this is drawn off the caustic solution is added a little at a time while agitating with air or open steam. Tests for acidity are made with any suitable indicator. Litmus paper may be used if precaution is taken to first moisten it with neutral water. The reason for this is that oil being the external phase of the emulsion, comes in contact with the paper first and once the paper is wet with oil it is scarcely possible to get the dispersed water particles in contact with the paper to show their reaction. Sometimes it requires considerable testing to get the true reaction. A drop of emulsion placed on the paper also allows a study of the texture of the emulsion and sometimes the breaking up of water particles can be noted independent of the acidity reaction. The emulsion usually breaks when the reaction is slightly on the acid side of the neutral point as shown by the litmus paper. This might be a fruitful field for studies in the application of hydrogen ion control. Occasionally a condition is reached where the litmus paper will show the presence of both acid and alkaline particles. This shows the need of more time and agitation to get these particles together. The experienced operator soon learns short cuts and familiar signs in handling a certain type of emulsion, such as the color of texture of bubbles, which attend the approach of the breaking point.

The importance of keeping acid sludge emulsions out of the sewers is becoming increasingly urgent because of contamination of streams. These emulsions are so nearly the same gravity as water that it is impossible to separate them in the ordinary oil trap, and even sand filters fail to completely remove them. Burning with fuel oil is a possibility since they readily mix with oil, and can be diluted to a point where the water entrained does not interfere. In any case it seems obvious that they must be put in condition for final disposal before leaving the treating department, as nothing is gained by allowing them to mix with the general plant sewage.

REFINERY STATISTICS

Washington.—On January 1, 1928, there were 423 completed refineries in the United States, according to the yearly survey conducted by the Bureau of Mines; and on that date five refineries, which will have 22,000 barrels capacity, were being built. The combined daily capacity of the 423 refineries was given as 3,250,380 barrels. On January 1, 1927, there had been 466 completed refineries in the country, but their total capacity was less than that of the 423 of this year, being only 3,061,007 barrels daily.

Of the completed refineries the first of this year, 326 with a capacity of 3,036,125 barrels, or 93 per cent. of the total capacity, were in operation; and 97 with a capacity of 214,255 barrels, or seven per cent. of the total, were shut down.

California ranked first in refining capacity, having 73 plants with 851,775 barrels capacity; Texas second with 74 plants of 622,380 barrels capacity; and Oklahoma third with 56 plants of 291,150 barrels daily capacity.

Information Circular 6065 contains the petroleum refinery directory, and may be obtained from the U. S. Bureau of Mines, Department of Commerce, Washington.

Methods and Cost of Re-Designing A Battery of Crude Fire Stills

By H. L. MINISTER

CRUDE FIRE STILLS are a means for fractional distillation of crude petroleums. This process, or the separation, by volatilization of one group of petroleum constituents from another, in some form of closed apparatus, by the aid of directly or indirectly applied heat, is the most important part of the whole scope of refining, and deserves far more consideration proportionately, than that given to the higher cracking processes.

Within the recess of crude fire still operations, are the most essential and difficult problems in the refining industry. Such factors, as the proper design and location of heat exchangers; still fire box construction; the losses due to waste heat, escaping gases; and the improper design of batteries of stills; will have all to do with modifications in the future fractional distillation methods used.

The biggest problem before refinery engineers is "heat exchange." Much time and money have been spent by the several larger refineries to determine "proper heat exchange." Only recently, an article in five parts, was printed in The Refiner and Natural Gasoline Manufacturer, (March, 1926, to July, 1926, inclusive,) that covered the theoretical side. This subject of heat exchange is equally important to boiler manufacturies. Tremendous savings and reductions in distillation costs rest within the solution of this problem.

Distillation by dry heat, or stripping, is the complete removal of all light fractions, down to those of lubricating value, and represents the initial refining process, generally employed today; and which is divided into two parts; namely,

A—Batch still operation,

B—Continuous still operation.

Prior to 1906, stripping was almost, essentially, a discontinuous batch still operation. As early as 1899, Livingston had perfected a continuous scheme of distillation. He patented the right in 1903. While the process was employed in certain refineries, it obviously was not in the industry at large; and it was some time later before continuous distillation supplanted batch stills. In fact it required the development of the automobile industry to further the distillation and cracking methods. Today, it is almost universally employed either in its entirety, or in a skimming modification.

While the continuous distillation of petroleum received its real impetus from Livingston's apparatus, it nevertheless had attracted attention as early as 1860, when Julius Brace and D. S. Stombs used a form of same in the distillation of coal oil. Again, in 1870, C. F. Thumm and S. A. Hill used same in "distillation of hydrocarbon oils." Samuel Van Syckel; the Noble Brothers; Schukow; Intchik, and Bary, Russians; Alexieev; likewise used some form of continuous distillation prior to Livington's successful operation of the same, at the Atlantic Refining Company in Philadelphia.

In continuous distillation, the oil is continuously supplied to a preparatory still, and flows ordinarily continuous through the successive stills, by one of the several methods; namely,

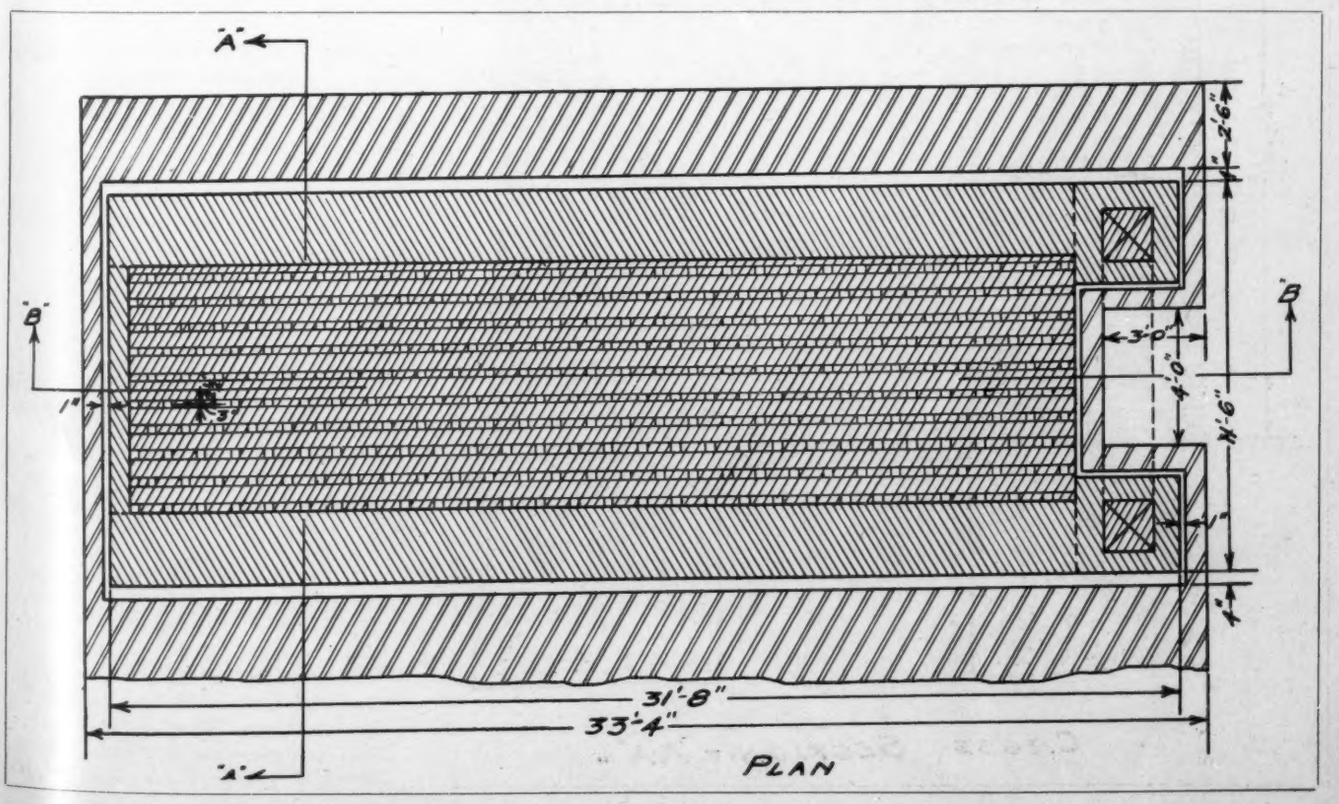
1—Pumping,

2—Gravity,

A—By arranging said liquid receiving mouths of the several connections at successively lower levels, in the series of stills.

B—Elevation of each successive still.

Vaporization contemporaneously proceeds in all the stills of the series as oil flows through them; each still being maintained at the temperature best adapted for producing the particular distillate obtainable from its contents. Distillation is carried on in a manner that will occasion a satisfactory quality of distillate and at the



same time avoid impairing the quality of the residium.

Chief Object

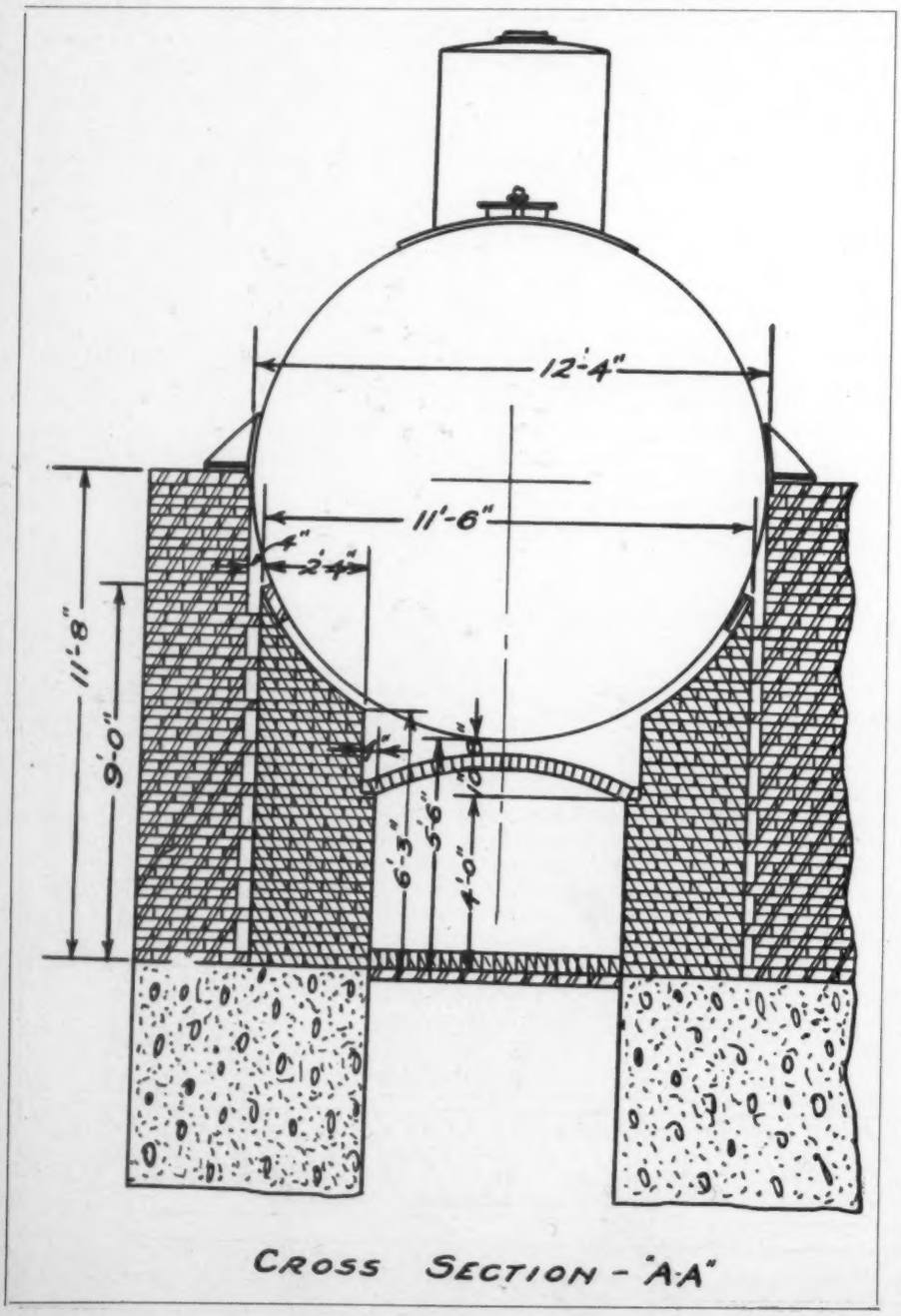
The main object is to perform crude oil distillation with the lowest possible fuel consumption, in a plant of the greatest capacity, while reducing, if not eliminating, redistillation of once-run fractions.

It has been proven that installations that comprise continuous equipment, erected in receding elevation, give the greatest capacity for the lowest cost. Each still of such a series is provided with by-pass valves so it may be cut out of continuous service and run down to fuel, or pumped out and cleaned, as conditions require.

The battery of 10 crude stills, whose reconditioning is herein described, were set on the horizontal plane. They were 12x32 foot stills. After several years of operation, the settings began crumbling, as some of the brick work was frozen in the original setting. It was deemed advisable to re-set the battery and put in new foundations.

The first essential in successful operation is "the proper construction of the furnaces to secure efficient combustion and uniform distribution of heat, over all parts of the heating surface." Practice has proven that the hottest part of the fire is about two-thirds of the distance back from the fire door.

The new furnaces were designed for maximum combustion and even distribution of heat. Each successive furnace being built to withstand the increasing heat, and give proper combustion volume. In the still furnaces, the fire brick were picked for their good wearing quality, rather than for composition to withstand abnormally high temperatures, it being more important that the brick be dipped in the thinnest bond of clay slip and then properly laid by skilled furnace brick layers.



Fuel Control Factors

The steel still details are the same as were used in original design, except the lengths of the columns, etc., were changed to meet the new settings. Receding elevation. The heat exchanger was designed and installed for most efficient heat exchange. It often runs a considerable stream of high gravity benzine or gasoline.

The gravities of the streams, from the series of stills in continuous distillation are dependent upon:

1—Gravity and composition of the crude oil.

2—Speed of flow, through the series.

3—Extent of firing of the individual stills.

Therefore, it is absolutely necessary, that still settings, furnace construction and proper temperatures be scrutinized to the utmost.

The amount of fuel consumed was found to be dependent on,

1—Gravity of crude.

2—Percentage of distillation.

3—Extent of dephlegmation practiced.

4—Furnace design.

5—Efficiency of shell insulation.

6—Degree of heat exchange.

The specifications for structural steel details, standard condensers and receiving house, have been thoroughly covered so many times that it is not necessary to repeat other than the details, as shown on the drawings.

Natural gas and fuel oil are to be used for fuel. Mostly natural gas.

The cost of continuous pumping apparatus was carefully considered and all costs on the re-vamping gone into before it was definitely decided to reconstruct.

Advantages of Receding Still Continuous Distillation

1—No pumps being required to pump from still to still.

2—Increased volume of crude oil treated.

3—Better furnace design.

4—Flexibility of operation.

5—Cuts down re-run materials.

Costs for Reconstruction; Gravity System

1—DISMANTLING

A—STILLS AND AIR CHAMBERS

1—Removing insulation .....$ 420.00

2—Steel work 240.00

3—Stills (includes hauling of 2500 ties, cribbing) 1,925.00

4—Removing pipe (sorting, rigging and overhauling) 2,175.00

5—Brickwork (stills and flues) 2,380.00

Kind of brick	No. removed	No. salvaged
Red brick	226,000	135,000
Fire brick	205,000	123,000
Face brick	22,500	13,300

6—Concrete (includes matte, stanchions and walls) 656 cu. yds. 8580.00

7—Air chambers, 139 cu. yds. (includes matte, top, walls, ends, inner flues) 1,739.00

B—CONDENSER BOX:
1—Top (includes pipe and steel work, scaffolding, sorting and repairs of fittings) 720.00
2—Coils in condenser box 1,470.00
3—Under condensers—
a. Heat exchanger 270.00
b. Manifolds 270.00
c. Concrete (includes breaking and hauling) 120.00
d. Cleaning up and hauling materials to salvage yard 400.00
C—RECEIVING HOUSE:
Mostly pipe work 630.00
D—MISCELLANEOUS and CONTINGENCIES 1,067.00

Total $22,406.00

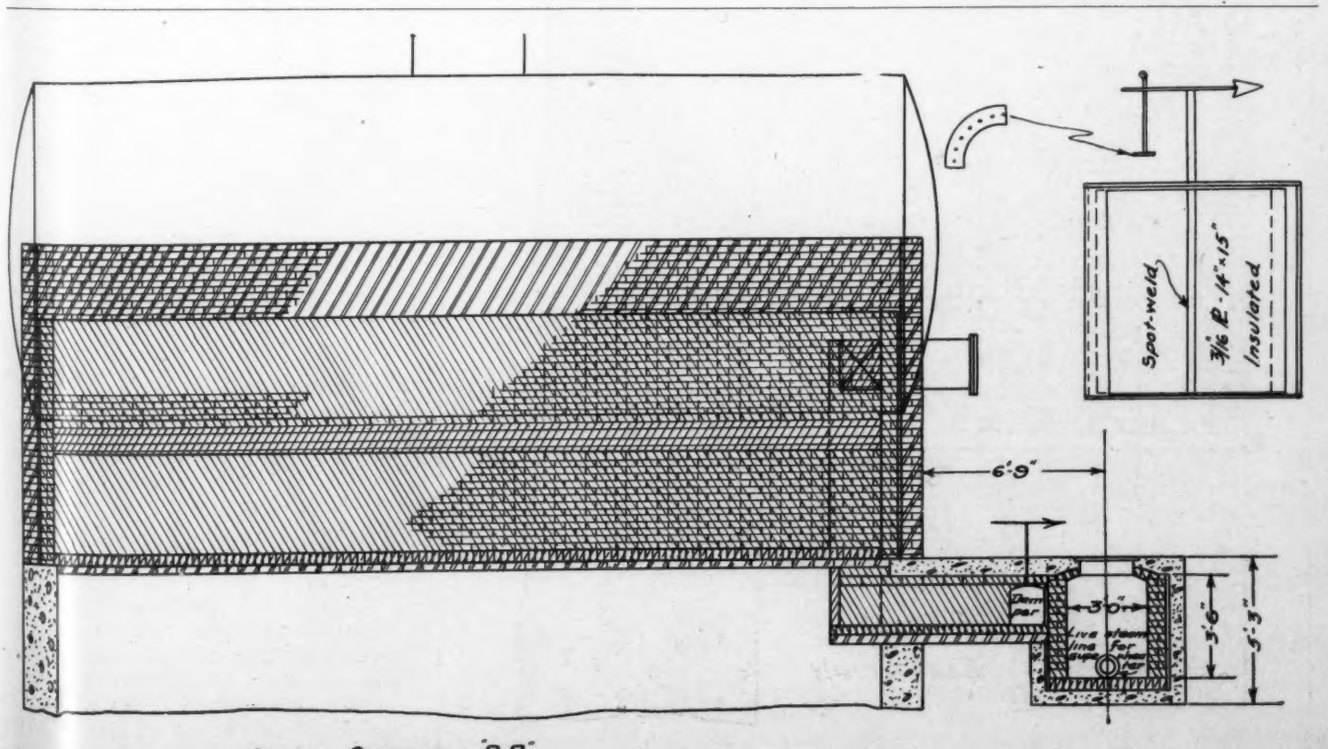
2—REBUILDING

A—STILLS AND FLUE: 9,788.00
1—Concrete under still settings, 666 yards.
2—Concrete, flue, 100 yards.
3—Concrete material required:
a. 920 bbls. cement, $3.80 per barrel.
b. 615 yards crushed rock, $3.50 per yard.
c. 354 yards washed sand, $4.64 per yard.
d. 13,000 B. M. lumber, $35.00 per 1000 B. M.
e. Steam, fuel, etc.
4—Steel stanchions for stills $15,500.00
a. 150,400 pounds steel sections, fabricated and in place; plates, columns, bases, etc.
5—Setting, ten 12x32 ft. fire stills (includes building up and tearing down cribbing, and returning ties, etc., to proper location) $2,600.00
6—Brick work on stills and flue 25,803.00
Stills—Type brick, number required, on hand, to purchase.

Face brick	24,000 000,000	24,500
(Cost, $30.00 per 1000)		
Fire brick	97,100 000,000	97,100
(First class; cost, $72.90 per 1000)		
Fire brick	85,000 86,000	00,000
(Second class)		
Common brick	215,000 125,000	90,000
(Cost, $26.40 per 1000)		
Fire arch brick	11,000 000,000	11,000
(Cost, $64.00 per 1000)		
Flue:		
Common brick	28,000 28,000	00,000
Fire brick	26,500 26,500	00,000

a. 400 bbl. cement at $3.80 per bbl.
b. 22 yards sand (washed), $4.64 per yard.
c. 2000 pounds Fire Clay, $14.00 cwt.
d. 35,000 pounds Hydrated lime, $3.08 per barrel.
e. 7,000 B. M. lumber.
f. Labor. etc.
7—Dirt, etc., in fire part 600.00
8—Insulation for ten 12x32 ft. stills (includes material and labor complete) 13,522.00
a. 38,000 9"x4½"x2½" Sil-o-cel brick.
b. 285, 100-lb. bags of No. 302 J. M. absestos cement (90 lbs. required for each 100 brick).
c. 9,560 lbs. Sil-o-cel hard finish cement .
d. 115 sacks Portland cement.
e. 255 lbs. 1" dia. J. M. No. 4296 Commercial asbestos twisted rope
f. 3,800 sq. ft. ¼" T and s6" wide J. M. asbestos rolled fire felt.
g. 30 lbs. J. M., No. 285 asbestos twisted cord.
h. 64 pcs. 48"x96"—18 ga. galv. iron sheeting.
i. 20,000 Lin. feet No 14 ga. soft annealed steel wire.
j. 11,000 sq. ft. No. 19 ga.—1"hex. mesh galv. chicken wire
k. 68 pcs. 2½"x2½"x¼" angle iron, 20 feet long.
l. 220 pcs.2½"x2½"x¼" angle iron, 4 inches long.
m. 17 pcs. 2½"x2½"¼" angle iron, 12 feet long.
n. 180 Lin. feet, 2½"x¼" flat bar steel.
o. 680 Lin. feet 2" std, black merchants pipe (threaded both ends).
p. 646 Lin feet 1" std. black merchant's pipe (not threaded).
q. 480 ½"x1¼" sq. head bolts and hex. nuts.
r. 128 1½" flashing hooks.

B—CONDENSER BOX: 2,000.00
1—Concrete.
a. Floor.
b. Partition.
c. Reinforcing steel (⅝" sq. twisted bar).
2—Repair sis towers (more baffles) 400.00
3—Three 4'x20' Deph. Towers, baffles, 2' apart 1,325.00
4—Condenser coils 15,266.00
a. 12,000', 4" Fl. C. I. pipe.
b. 160 6" Fl. C. I. ells.
c. 400 4" Fl. C. I. ells.
5—Covering ten chambers 1,579.00
a. 500 pcs. 2'x3'x2' TH asbestos sheet.
b.—50 100 lb. bags asbestos fibre.
c. 47 100-lb. bags asbestos cement.
d. Ready mixed asbestile.
e. 125 gallons Silo.
f. 518' No. 9 wire for roping.



CROSS SECTION - BB

g. 3211 sq. feet, 20 ga. ¾" mesh mesh chicken wire.
h. 4,300 B. M. form lumber.

6—Setting towers 200,00
7—Coils in condenser boxes (labor only) 1,020.00
8—Setting pumps and pipe labor 552.00
9—Setting heat exchanger and pipe work 500.00

C—WALKWAYS over STILLS and CONDENSER BOXES
1—Labor and materials 4,722.00

D—RECEIVING HOUSE
(Includes 18 yds. concrete lower floor, subway grating, drainage, and cutting slots in upper floor) 643.00

E—PIPE WORK
(All material from dismantling used in re-piping. Extra material and labor on whole figured).

1—Receiving house ..	1,020.00	7,975.00
2—Condenser box to receiving house	523.00	715.00
3—Heat exchanger ..		1,832.00
4—Under condenser box including 4 10x6x10 pumps . ..	500.00	1,812.00
5—Vapor lines	945.00	850.00
6—Two equalizer lines	164.00	500.00
7—Sample lines	42.00	250.00
8—Continuous lines	246.00	250.00
9—Air lines	82.00	200.00
10—Tar lines	205.00	949.00
11—Steam lines over stills	82.00	250.00
12—Headers and towers	205.00	
13—Burners	296.00	
14—Crude lines over stills	164.00	
15—Pipe work inside of stills	410.00	
16—Knock-back lines	12.00	

F—MISCELLANEOUS SHOP LABOR 850.00
1—Common labor 500.00
2—Misc. crane work 250.00
G—5 per cent. CONTINGENCIES 5,910.00

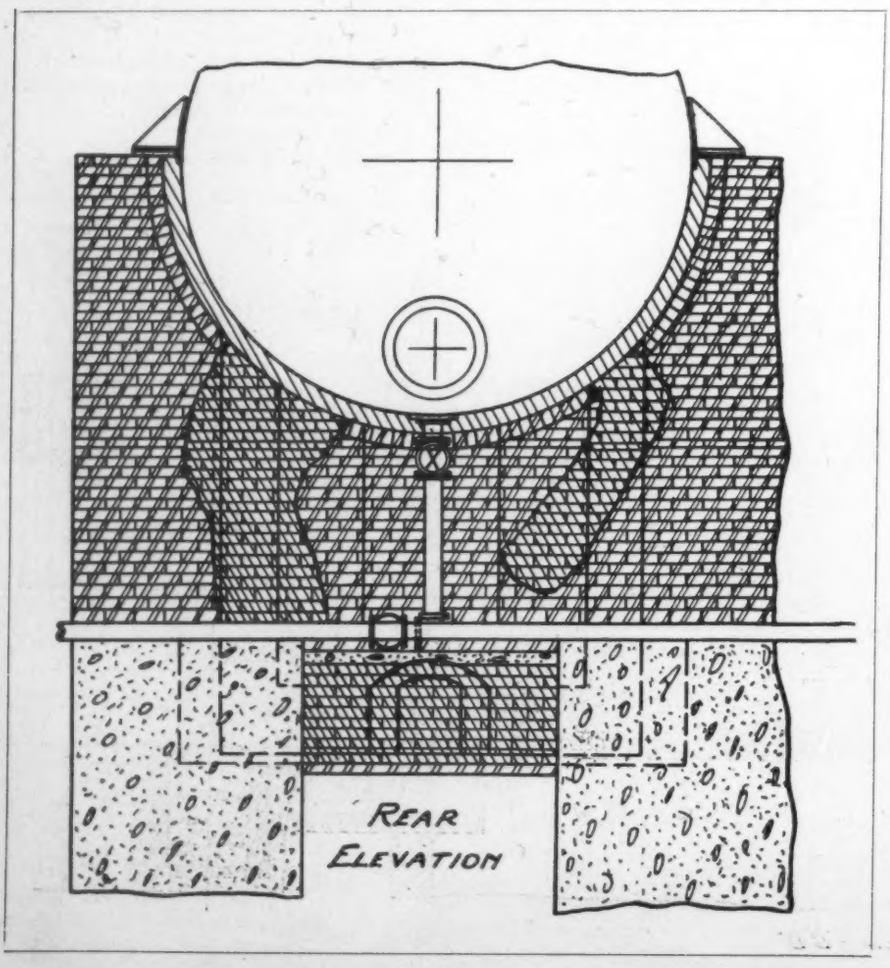
Total $124,120.00
GRAND TOTAL $146,526.00

GILMORE PLANTS

Tulsa.—The Forest E. Gilmore Company started construction of two new gasoline plants in the Little River pool of Greater Seminole area early in June. Gilmore's plant number 13 will be located in the south end of the field and will be the largest installation from the standpoint of gasoline production which this company has. Its plant number 14 is to be located in the north end of the field. Both plants will be of the compression type, equipped with the company's type of fractionating and rectifying equipment which produces a stable gasoline from the compression system, and will operate in conjunction with gas lift systems for flowing oil wells in the Little River pool. Both plants are to be erected under the company's type of unit construction which permits of ease of enlargement to greater capacity whenever necessary without disturbing the operating units at the time.

The company recently completed enlargement of its gasoline plant No. 10 in the Seminole area, through the installation of four Clark twin compressor machines, 180 horsepower, and a new water cooling system, as well as more condenser and absorber equipment. The plant now has a total of 13 units, the recent addition effecting an increase in capacity of 8,000 gallons of gasoline daily. Plant capacity is now around 30,000 gallons.

The Gilmore Company also recently completed erection of its absorption type natural gasoline plant in the Allen, Oklahoma, field. This plant, No. 12, started operating May 24, producing gasoline at the rate of 10,000 gallons daily. The product is to be marketed as commercial gasoline having the approximate specifications of 68/70 gravity and 360 end point. Gas treated comes partly from the Southwest Gas Company gas pipe line, about 30 million cubic feet, and partly low or natural pressure gas from the field—about 10,000,000 cubic feet. The plant consists of equipment designed by the Gilmore engineers and the Tulsa Boiler & Machinery Company condensing equipment, which is in use in a number of the Gilmore Company gasoline plants.



MAGNOLIA MOVING PLANTS

Dallas.—Magnolia Petroleum Company, one of the largest natural gasoline manufacturers, having 37 plants in operation now, is dismantling 12 plants in the Mid-Continent territory, all of them being of the compression type, and in most cases is moving them to other plants.

The plants that are being dismantled include the following in Texas: Archer, Parish lease; Burk No. 3 in the Schmisseur "B" lease; Commanche No. 2, Woodward lease; Commanche No. 4, Mathews lease; and the Olden No. 2 on the Connallee lease.

In Oklahoma the plants dismantled include the Cushing No. 4, Scott lease; Cushing No. 6, Eagle lease; Davenport No. 2 on the Sukovaty lease; and the Okmulgee plant on the Lanning lease. In Arkansas the Union No. 3 on the Slaughter lease is being dismantled.

Houston. — The New Orleans Refining Company of New Orleans has contracted with the Independent Oil & Gas Company for 1,000,000 barrels of crude to be shipped to its refinery at Norco, 30 miles east of New Orleans on the Mississippi River.

Cutting Oils—Their Characteristics And Manufacture

By GEORGE W. CUPIT, JR.
Chemical and Refining Engineer

SO difficult is the task that the petroleum chemist and the refiner have found it an endless task in working out dependable formulae and practical plant methods for the manufacture of cutting oils. As the name implies, these oils are used in cutting metals, and should aid the cutting tool in doing its work accurately without injury to itself or the metal being cut.

Before entering into the discussion of their characteristics, qualifications and manufacture, it is of sufficient importance to explain the requirements cutting oils should meet. The following procedure should be carried out in preparation for their use.

1. It is necessary to cool the work and tool cutting edge area;

2. Furnish lubrication between the lip of the tool and the chip;

3. Flush out the cutting area (thereby freeing it from small metallic particles:)

4. Give a finish to the work;

5. Protect the surface of the finished work from rusting;

6. Reduce the cost of metal cutting;

Each of the above has its significance from the start.

The cost of cutting metal is likewise important and is dependable upon the following:

1. Cost of the tool steel;

2. Cost of labor:
   (a) Machine operator's time.
   (b) Operator's time lost in replacing dull tools.
   (c) Time cost for redressing dull tools.

3. Cost of the power required to drive the machine.

4. Cost of the cutting fluid.

The cost of the cutting fluid is reducible by selecting a cutting fluid which efficiently functions according to the foregoing requirements for the longest time, giving the greatest production, with due consideration given to initial cost.

Coincident with the rapid development of high speed tools came the demand for water soluble oil cutting mixtures. Of all liquids available for cooling the cutting operation, water has the highest heat absorbing qualities, but water, used alone, is deficient in lubricating qualities, and is also objectionable, due to its rusting effects. In a great many instances cutting pastes are used, but in the majority of cases, cutting oils are found more convenient, and do better work.

The cutting oils, when mixed with warm or cold water in any proportion, readily form stable, rich, milky emulsions, the emulsified oil content giving efficient lubrication, finish and rust protection, while water carries the fluid in, and the heat out. The work turned out by a good cutting oil is characterized by a bright, fine, smooth finish. A relatively high proportion of water can be carried by the emulsion when a good cutting oil is used, thereby insuring a low cost per gallon of the mix.

Properties of Cutting Oils

A good soluble cutting oil should have the following properties:

1. It should preferably be clear and should not segregate in layers upon standing in a closed vessel.

2. It should readily emulsify when added to water of ordinary temperature (70-80 degrees F.).

3. An emulsion, containing 5.0 per cent. of soluble cutting oil, kept in a stoppered bottle for 24 hours, should not show any separation of oil and only a minimum amount of white scum.

4. When exposed to air, a minimum amount of solid film should form upon the surface of the oil.

5. When a 5.0 per cent. emulsion is violently shaken, a minimum amount of foam only should be produced, which should rapidly disappear upon discontinuing the agitation.

6. The 5.0 per cent. emulsion should have a minimum sensitiveness to added electrolytes.

7. The emulsion should produce clean cuts, when used with cutting tools.

8. The emulsion should not corrode metals or cause rusting of iron or steel.

From the above eight properties it can readily be seen that they are fundamental.

Sulphur is a very important constituent of cutting oils. It may be present in the combined or the free state as well as in both in the one and the same cutting oil. In the ordinary inspection of cutting oils, the total sulphur contents are generally determined and the amount of free sulphur contained is generally estimated by subtracting from the total sulphur the amount of sulphur corresponding to the character of the mineral oil used as base for the cutting oil. It was, therefore, desired to find a method for the direct determination of free sulphur, as it had been found that many cutting oils, prepared by dissolving in mineral oils proportions of sulphur corresponding to those estimated by above method, separated sulphur crystals upon standing and thus must be considered as supersaturated solutions.

Determining Free Sulphur

The following method gave reliable and accurate results and was therefore adopted:

About 25 gr. of the cutting oil to be examined and 100 cc of a clear solution of sodium sulfite, containing 15 gr. Na 2SO3, are placed in a 300 cc Erlenmeyer flask and heated under a reflux condenser upon an actively boiling steam-bath for 24 hours. The flask and contents are occasionally shaken, especially during the first hours of the operation. After finished digesting, the aqueous solution is drawn off and 100 cc distilled water are added to the oil, after which the flask and contents are again heated for two hours upon the steam-bath. The oil and water are separated, the former is dried, and a sample of it is analyzed for sulfur, as well as a sample of the original oil. The difference is the free sulphur contained in the oil.

In the case of a black viscous oil, an addition of 25-30 cc sulphur free benzol will materially aid in the digestion of the oil and subsequent separation of the aqueous solution. The benzol is evaporated upon the steam-bath.

The aqueous solution of sodium sulfite, withdrawn from the digested oil, is cooled and filtered through paper until clear. To 10 cc of the clear filtrate are gradually added 5 cc of conc. sulfuric acid, with shaking. If upon standing, a more or less heavy precipitate of sulphur is formed, free sulphur is contained in the oil and extracted oil should be analyzed, as directed above. If only a faint turbidity is noticed, no free sulphur is contained in the oil, and the analysis of the digested oil may be omitted.

The method was tested in different manners and on different oils. Of the latter, some had been made up in the laboratory, and as their composition was known, they served as checks upon the reliability of the method. The

results, which are collected in attached table, show that the method is accurate enough for use in examining cutting oils:

DETERMINATION OF FREE SULPHUR IN CUTTING OILS

	Total Sul. %	Sulf. After Digest	Free Sul. %	Sulf. in Original Stock %	Sulf. added To stock %	Reaction of Aqueous sol. With H_2SO_4
No. 1	0.35	0.29	0.06	0.35	none	Opalescence
No. 2	1.15	0.24	0.91	0.35	1	Precipitate
No. 3	1.29	0.30	0.99	0.33	1	Precipitate
No. 4	1.55	0.26	1.29	....	..	Precipitate
No. 5	1.65	0.26	1.39	....	..	Precipitate
No. 6	1.44	0.29	1.15	....	..	Precipitate
No. 7	1.44	0.13	1.31	....	..	Precipitate
No. 8	1.74	0.84	0.90	....	..	Precipitate
No. 9	1.74	0.73	1.01	....	..	Precipitate
No. 10	0.73	0.08	0.65	....	..	Precipitate

Oleates and Resinates Often Used

Any substance that is absorbed from a solution by another substance tends to disperse the latter. Such substances are the oleates and resinates of the alkali metals (soaps) and free oleic acid.

When the soap solutions in dilute alcohol are neutral to phenolphtalein, their aqueous solutions prepared as described will show alkaline reaction. The oleate solutions prepared as described will show considerably higher alkalinity than those containing resinates.

The amount of oil retained by a given soap solution increases with a decrease in the viscosity of the oil. For instance, four volumes of water white, mixed with one volume of Na-oleate solution of 50 per cent. soap (approximately) will give a gelatinous mix, which does not separate on standing. A similar mix of Batching Oil and soap solution will separate in two layers, some of the oil being retained by the soap solution, while a mix of soap solution with Solar red oil will separate out still more oil. Solutions of resinates have a much smaller tendency to retain oil than oleate solutions. Dilute soap solutions retain less oil than more concentrated solutions.

Neutral soaps are very little adsorbed by mineral oils from solutions in dilute alcohol and therefore soaps alone can not be used to produce dispersions of oil in dilute alcohol.

If Elain is added to a turbid mix of a neutral soap dissolved in dilute alcohol and mineral oil, the addition being gradual and the mix is allowed to settle after each addition, it will be noticed that the volume of mineral oil that settles out will decrease with each addition and that finally a clear, homogeneous, non-segregating mix will result.

The amount of Elain necessary to produce a clear mix from a mixture of mineral oil and soap solution varies with the quality of the used oil and soap solution and with the ratio of soap solution to mineral oil. If the composition of the soap solution is constant, a high viscosity mineral oil will require more Elain than a low viscosity oil. An oil that has a high interfacial tension towards water needs more Elain to produce a clear mix with a given soap solution than a mineral oil of low interfacial tension. If a solution of sodium oleate is used with a given mineral oil, less Elain is needed for the desired purpose than if a sodium resinate of the same concentration is used. If the ratio of mineral oil to soap solution is raised, the needed Elain will also be increased.

These manifold and varying influences make it necessary to produce the clear mixes in an empirical way. A good way to proceed is the following: Mix a suitable soap solution with mineral oil, in the chosen proportions and then gradually add the Elain, until the mixture becomes homogeneous and remains that way after standing for several hours.

Producing a Soluble Cutting Oil

The emulsion formed by adding 5 vol. of Soluble Cutting Oil to 95 vol. of water at ordinary temperature should be as permanent as possible, that is, should not separate into a lower milky layer and an upper layer of oil or mush after standing for 24 hours. A very slight trace of white scum is permissible.

The procedure should be carried out in the following way:

1—Mix 1 vol. of soap solution with 4 vol. of the mineral oil.

2—Add Elain to the mix gradually mixing well, until the produced oil is clear. Determine the amount of Elain added.

3—Test the solubility of a small sample of the mix. If insoluble in water, the concentration of soap solution should be lowered by adding dilute alcohol to the mix and clearing the produced turbid mix by gradual addition of Elain. If soluble to a rich milky liquid proceed as follows:

4—Make a "base" by mixing the soap with Elain in the proportions found under 2 (or 3, if diluted with alcohol).

5—Mix one volume of this base with 3 vol of the mineral oil. (This relation of volumes is chosen as most commercial bases are mixed 1 of base to 3 of oil). A clear mix should result, or the amount of Elain used is too low and should be corrected.

6—Prepare an emulsion from 5 cc of Soluble Cutting Oil from (5) and 95 cc of water. Let stand. If an upper layer appears or if the emulsion gives a permanent foam upon shaking add carefully and gradually a saturated solution of Na_2Co_3. Test by making up emulsions adding Na_2Co_3 solution until the emulsions are permanent.

The formation of a solid film on the surface of a soluble cutting oil exposed to the air, is caused by the evaporation of the solvent of the soap in the oil, and especially of the alcohol, contained in the solvent. This evaporation disturbs the equilibrium between the various components in the oil and may cause this to be insoluble in water. Even if this stage is not reached, the solubility of the oil and the permanency of the formed emulsion will be decreased.

Avoiding Evaporation

The evaporation of solvent can not be avoided in an open vessel, and soluble cutting oils, containing alcohol should therefore never be exposed to air more than absolutely necessary. It is possible, however, to minimize the evaporation by using such soaps, as will produce soluble cutting oils even when dissolved in alcohol of low strength. This means the resinates. The oleates are much more apt to form films, depending upon the great difference between their solubilities in alcohol of medium and low strength. If the alcohol is partly removed from a solution of sodium oleate for instance 50 per cent. alucohol, the remaining solution will tend to solidify, while a solution of sodium resinate of similar composition, treated in the same way, will only become slightly more viscous.

The more successful way of avoiding the formation of films is therefore to use rosin soap in the weakest possible alcohol.

The formation of excessive and persistent foam when shaking a 5 per cent. emulsion of soluble cutting oils is caused by the presence of an excess of free Elain. This may have been added in excess when preparing the oil, or may be liberated by hydrolysis, when preparing the emulsion. In both cases, addition of Na_2Co_3 solution to the oil, as described before will lessen the foaming.

The use of the easily hydrolysed sodium oleate for preparing the soluble cutting oil will increase the tendency towards foaming.

The persistency of the foam seems to increase with increase in the viscosity of the used mineral oil.

Sensitivity Toward Electrolytes

The sensitiveness of an emulsion of soluble cutting oils to added electrolytes depends upon the amount of electrolyte added, and upon the character of this. All emulsion will be broken if enough electrolyte is added. If only small quantities are added, (NaOH or Na_2Co_3 are least harmful), there is

hardly any influence in n/10 solutions. Sodium chloride has much stronger influence. Calcium chloride has a distinct influence in n/100 solution and is equalled by HCl. This, as well as other acids and very dilute solutions of Al and Fe salts, break emulsions or prevent the formation of emulsions from soluble cutting oils and water in which they are contained.

Low temperature seems to favor the action of electrolytes. Thus, a natural water, containing much Al salts, gives a mush when shaken with Soluble Cutting Oils at 60° F., while an emulsion was formed when the two components were shaken at 85° F.

Several experiments to find the corrosive action of Soluble Cutting Oil were made by wetting pieces of clean steel and iron with 5 per cent. emulsions of cutting oils, and allowing them to dry under a bell jar. The air enclosed in this was kept saturated with moisture; pieces of steel and iron, not treated with emulsions, were kept under the bell jar as checks. The untreated pieces rusted while the pieces that had been wet with the emulsion showed no sign of rusting. The soluble cutting oil thus seems to act more like a rust preventive than a cause of corrosion.

Type II—Cutting Oil

Up to this point have been discussed the characteristics and manufacture of those cutting oils belonging to Type I. (Oleates and Resinates.) It should be remembered, before passing on to Type II, that there must exist a definite ratio at all times between the prime component parts of these oils. This definite ratio has already been determined for every general type of cutting oil and has been discussed for Type I.

In taking up the discussion of Type II the starting point is that of selecting the best mineral oil from which the Cutting Oil stock is to be made. A thorough study was made of the various types of oils (Paraffine, Asphaltic, Naphthenic), to determine the affinity each had for sulphur at definite temperatures. It was interesting to note that a typical Texas Gulf Coast Crude showed the best possibilities. It was, therefore, decided to make a cutting oil stock from this crude.

Still Operation: The crude oil is charged to the still after all preparations for still charging have carefully been made. The stills used may be batch for running the crude or they may be continuous. As the case may be, after the still has been charged, the fires are started and turned on full blast until the first over starts to run through the receiving house, at which time the fires are slackened enough to give a good stream.

The overhead cut is the one in which we are particularly interested. The first Cut No. 1, represents gas oil and is made by cutting into the gas oil tank from over to 60 Vis. at 100° F. Saybolt, on the worm. Cut No. 2 is cut into the 250 Stock tank at 60 Vis. at 100° F. Saybolt and out at 115 Vis. at 100° F. Saybolt on the worm. In order to increase the percentage 250 Stock, two subsequent cuts are made: Cut No. 3, 115 Vis. at 100 ° F. Saybolt to 22.5° Be on the worm, and Cut No. 4, 22.5° Be, 19.5° Be gravity on the worm. The name given Cut No. 3 is 250 Vis Distillate and that given Cut No. 4 is Heavy 250 Stock. The latter cut is combined with Cut No. 2 and called 250 Stock. This represents the cutting oil stock provided the Heavy 250 Stock (Cut No. 4) was heavy enough to bring the viscosity of the aggregate up to 130-135 Vis. at 100° F. Saybolt. If not, the 250 Stock is recharged to still and reduced to 135 Vis., 140 Vis. at 100° F. Saybolt. This stock is pumped into a storage tank where it is kept for further processing.

Sulphur Treatment

The 250 Vis. cutting oil stock itself contains from .4 to .6 per cent. sulphur and this must be taken into consideration when adding the required amount of this element to meet specifications. In making up a batch of cutting oil flowers of sulphur is used, the correct amount is added to the oil according to specifications. When the sulphur has been added, steam is turned into the closed heating coils in the agitator and the temperature of the oil and sulphur brought up slowly to 100° F. without agitation. When this temperature has been reached the mass is gently agitated for approximately 24 hours, with air. A representative sample is taken from the agitator while blowing and tested for free sulphur content. If the oil has not taken up sufficient sulphur to meet the specification range, 1.0 to 1.24 per cent, agitation should be continued without allowing the temperature to rise more than approximately 15 to 20 degrees. It has been found necessary to blow as long as 60 hours in order to get the required amount of sulphur to be taken up by the oil. When the sulphur content is correct, the mass should be smooth, homogeneous, possess a dark amber color and should meet the following specifications:

Viscosity, 135 to 145 at 100° F.; flash, 290° F. (minimum); per cent free sulphur, 1.0 to 1.24.

In order to remove the undesirable odor of the sulphur approximately 4 oz. of Oil of Sassafras per barrel of cutting oil made should be used and added prior to shutting off air agitation. The cutting oil made by the above method gave very satisfactory results where fairly heavy cutting was made. For extra heavy cutting Sulphonated Lard Oil was added to the mineral oil to bring the sulphur content of the final product up to 2.30 per cent.

Pine Tar has often been used instead of oil of sassafras as odorizer and where this is the case, (when no fatty oil has been used), the high soponification value present may be due to either the Pine Tar odorizer or oxidized mineral oil present. The result of the high saponification value when Pine Tar has been used should not cause the analytical chemist to believe that a fatty oil has been used, especially when analyzing an unknown oil.

It is possible to increase the sulphur content of an oil by carrying out the procedure at a much higher temperature than 100-120 degrees F. Say for instance 182 degrees F. The total percentage sulphur will show 3.33 while the percentage dissolved sulphur at that temperature shows 2.93.

By agitating the Flowers of Sulphur and the stock for several hours above the melting point of sulphur (239 degrees F.), in this case 260 degrees F. caused the oil when worked at this temperature to take up 12.30 per cent. sulphur. This increase in sulphur in the oil does not produce any material advantage. In the case of such a large increase of sulphur it has even been proved harmful to the cutting qualities of the oil.

Quality of Cutting Oils

This factor may be ascertained by the following:

1. By determining the power consumption when cutting threads at a speed of thirty (30) R.P.M.

2. By determining the increase in power consumption with continued use of one die.

3. By comparison of the increase in power consumption with increase in cutting speed.

It may be stated here that an increase in the viscosity of the cutting oil would not be beneficial in any way and would, of course, increase the cost of oil. It is not feasible to increase the sulphur content in the oil above the present ratio. It would really be better to lower the same to 1.0-1.20 per cent. free sulphur, as this would tend to minimize the possibilities of sulphur separating, especially in cold weather. In connection with this it should be stated that the high sulphur content of some Black Sulphur Oils, are to a great extent due to natural combined sulphur, not more free sulphur being found in these oils than the one which we made above, i.e., .95-1.24 per cent., to be exact. A light oil is very desirable from a selling point of view, but that it is more desirable to have the oil uniform in color; it should be noted that the only color specification given by the author for the 135 viscosity at 100 degrees F. Saybolt Cutting Oil is that it should be transparent in the neck of a four-ounce bottle.

Some of the uses of Cutting Oils are the following:

Lathes, screw making, pipe cutting, bolts and nuts, small delicate machines, general shop work, small tool making, automobile and parts, fire arms, etc.

When preparing soluble cutting oil, sodium resinates are preferable to sodium oleate. The resinates may be prepared by mixing the equivalent quantities of rosin

(Continued on Page 71)

The Vertical Steam Still as Applied to Fat Oil Distillation Service*

By E. G. ROGATZ
Union Oil Company of California

IT is generally recognized that the so-called vertical steam still presents the best type of layout for the economical stripping of natural gasoline from a fat absorption oil. The present development of this equipment is largely the result of a gradual evolution based on practical operating experience. The refinement stage of this apparatus, however, has now reached the point where it is necessary to rather carefully scrutinize the basic physical phenomena involved in its operation if we are to further increase its efficiency. It is not the purpose of this paper to present a mathematical analysis of these phenomena, but rather to call attention to the fundamental operating effects required of the equipment, and to some of the simple controlling physical relationships underlying the same.

At the start, it is necessary to understand that the fat absorption oil still has two distinct operations to perform, namely, the stripping of the natural gasoline from the fat absorption oil, and the subsequent fractionating of these stripped vapors to produce a correct endpoint gasoline. While these two operations overlap to some extent, they may be analyzed as independent phases and assigned to distinct sections of the apparatus. The physical phenomena involved in these two operations vary to a considerable degree.

On the accompanying diagrammatic layout of such a vertical steam still, the stripping and fractionating sections have been indicated as separate units for the purpose of emphasizing this distinction between the operating effects required of the two sections. In actual practice, of course, the fractionating section is usually superimposed upon the stripping section.

Now all distillation operations involve the transfer between liquid and vapor phases of certain fractions of the materials undergoing treatment; this transfer being effected by the tendency of all intimately contracted vapor and liquid phase to come to pressure equilibrium. That is, all intimate liquid-vapor systems tend to reach a static condition in which the vapor pressure of any constituent in the liquid phase just equals the partial pressure of that constituent in the vapor phase.

In the operation of a still we first upset the liquid-vapor pressure equilibrium of the feed material, and then promote a new equilibrium in which the various fractions of the original feed material are recombined in the forms desired. There are many ways of upsetting such an equilibrium, two of which consist of the introducing of an insoluble vapor into the system, as for instance, steam into a srtipping column, and the changing of the temperature relationship of the vapor-liquid mixture, as in the temperature reflux control in the fractionating column.

*Before the California Natural Gasoline Association, Los Angeles, May 10, 1928.

Stripping System

In general, the stripping phase of the fat oil distillation operation consists of the introduction of a preheated feed into the top of a stripping section, with the subsequent removal of its gasoline content through a counter-current scrubbing action obtained from saturated or superheated steam admitted to the bottom of the column. With respect to this operation, it should be noted that the feed to such a column is usually preheated to such an extent that the lightest fractions of the gasoline spontaneously vaporize at the feed plate; leaving only the heavier ends to be differentially stripped out by the ascending steam.

Lewis and McAdams (Industrial and Engineering Chemistry—March, 1928), have thoroughly analyzed the phenomena involved in this phase of the distillation process, and developed a method of graphically predicting the results obtainable with certain special counter-current stripping systems. We will not go into the details of their graphical analysis, but certain equilibrium relationships brought out in their article are basic, and deserve special emphasis in any discussion of counter-current stripping operations.

In the development of these special equilibrium relationships, however, it is first necessary to visualize the physical mechanism whereby the desired transfer of various fractions between the liquid and vapor phases is effected. As we have already stated, the driving force back of this transfer is the difference existing between the vapor pressure of a fraction in the liquid state and the partial pressure of that same fraction in the vapor state, the respective vapors and liquids being in intimate contact but not in equilibrium with each other. If the partial pressure of the vapor fraction exceeds the vapor pressure of the liquid fraction, the transfer will be from vapor to liquid, and absorption will take place; while if the relative pressures are reversed, vapors will leave the liquid and stripping will take place.

Now this transfer must be effected through a boundary surface, or interface, between the liquid and vapor bodies, and it is generally assumed that the major resistance to the phase transfer of the migrating fraction resides in the resistance to diffusion of the transferred material through this boundary. Furthermore, this interface is made up of two fluid films, one liquid and one vapor, which are usually considered to be in pressure equilibrium with each other. Under these conditions, it will be seen that the particles of transferring material must migrate in and out of the boundary films due to the pressure differences existing between the main body pressure of the liquid or vapor and its respective film pressure at the interface.

Furthermore, in the special case of natural gasoline fractions dissolved in a fat absorption oil, we find that the dissolved fractions rather closely obey Raoult's law, that is:

$P_v = P \times X$

Where:

P_v = The vapor pressure of a dissolved fraction in solution at some temperature Tx.

P = The vapor pressure of the dissolved fraction when in a pure state at the temperature Tx.

X = The molal concentration of the dissolved fraction in the solution.

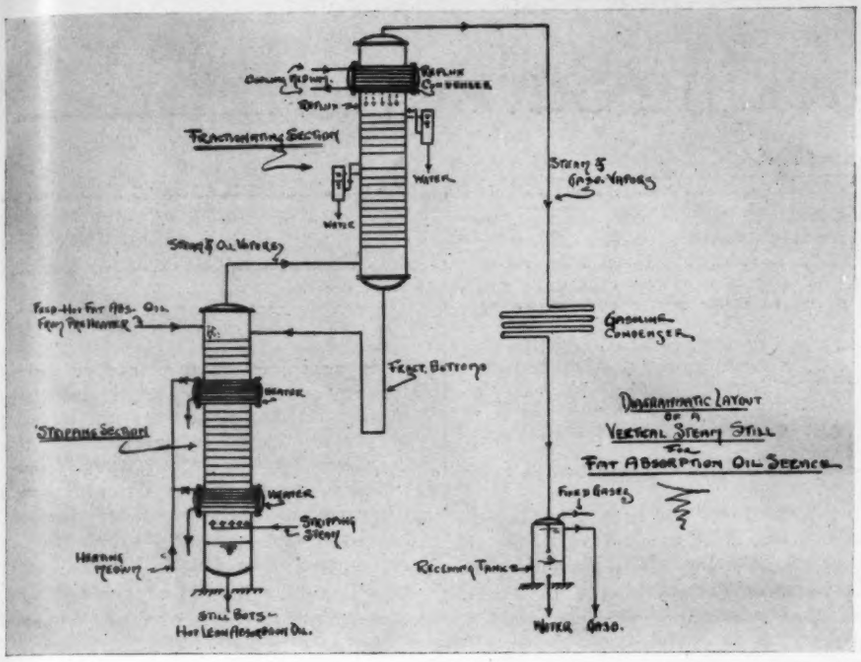
From this equation we see that, as long as the gasoline fractions are in intimate equilibrium contact with the absorption oil, their partial pressure will always be less than that of pure gasoline at any given temperature Tx. However, if we know the molal concentration of the gasoline fractions in the absorption oil, we can then compute their reduced vapor pressure by the simple relationship given above.

Lewis and McAdams have combined the concept of an equilibrium boundary phase with the special case of a stripping operation in which the dissolved component obeys Raoult's law, and developed therefrom the following important relationships.

Maximum Temperature Control

(1) For maximum steam economy, all sections of a stripping column should be maintained at a maximum temperature and minimum pressure.

We have always recognized that more complete stripping can be obtained under conditions of lower column pressure, but the additional consideration that all sections of the column should be held at a maximum temperature is not so generally understood. With respect to this temperature phase of the control, it should be emphasized that all sections of the stripping column must be held at the *same* maximum temperature for highest steam economy. This maximum temperature, of course, will be determined by practical



operating limitations such as the temperature obtainable from available high pressure steam, and the operating temperature limits set by the gum-forming tendencies exhibited by most absorption oils.

This requirement of uniform temperature for maximum steam economy at the stripping column, automatically demands heating coils in the stripping unit for supplying the latent heat of vaporization required for the stripped gasoline fractions. Few of the older column contain such coils and most of the newer designs have coils only at the bottom of the column. However, the severest cooling effect in the entire stripping section is developed at the feed plate; for at this point, a large proportion of the gasoline fractions spontaneously vaporize out of the heated fat absorption oil as they encounter the steam laden atmosphere of the column. The spontaneous vaporization of these gasoline fractions, in turn, results in a material cooling of the remaining liquid undergoing treatment.

Now the best theoretical stripping column layout would contain heating coils of adequate size on each stripping tray. However, if such an installation does not appear practical from an operating and structural standpoint, then we should investigate the feasibility of using at least two sets of heating coils; one near the top of the stripping section for supplying the "flash" latent heat and the other at the bottom of the column for maintaining a relatively high average temperature through the unit.

If the lean absorption oil leaving the column is to be stripped of substantially all of its gasoline content, then the steam leaving the column can only be partially saturated. Furthermore, the quantity of steam required per barrel of absorption oil handled, at a given temperature Tx, will be independent of the concentration of gasoline in the original fat absorption oil.

Remembering that the stripping column under discussion is uniformly heated to a definite temperature Tx, this statement then emphasizes that, be the gasoline concentration in the fat oil high or low, the same quantity of steam should always strip the same quantity of absorption oil to substantially the same degree of leanness.

The basis for this assertion resides in the fact that the natural gasoline fractions dissolved in an absorption oil obey Raoult's law.

At the top of the column, where we find a large proportion of gasoline fractions at a relatively high partial pressure in the steam atmosphere, we also find a relatively large quantity of gasoline in the absorption oil—where it in turn can exert a relatively high vapor pressure. Consequently, a certain proportion of the high vapor pressure liquid gasoline fractions can overcome the high partial pressure of the gasoline vapors and migrate out of the absorption oil into the vapor stream.

In contrast, at the bottom of the column, we find a very low concentration of gasoline fractions in the absorption oil where they, in turn, exert a much lower partial pressure. However, the concentration of gasoline fractions in the steam atmosphere at this end of the column is also low, consequently some liquid gasoline fractions can still exert sufficient pressure to migrate from the absorption oil into the vapor stream at this stage of the operation.

Constant Steam-Oil Ratio

This idea of a constant steam-oil ratio, I know, is relatively new to many of us. Incidentally, it has a corollary to the effect that the quantity of lean oil required at the absorption column for a given final leanness of tail gas is independent of the initial rich gas saturation. Therefore, with properly designed columns, the consumption of steam and quantity of circulation oil handled should be, within reasonable limits, a function only of the quantity of gas handled, irrespective of its relative richness.

By mathematically combining statements Nos. 1 and 2, it may be proved that, for a given temperature Tx, the consumption of steam in a perfect column will be directly proportional to $\frac{\pi}{P}$ where π is the total pressure carried on the column and P is the pure state absolute vapor pressure at Tx of the heaviest fraction stripped from the absorption oil; it being further noted that if the stripping operation involves the removal of a series of components of relatively different volatilities, as is the case with a fat absorption oil, then the steam consumption is determined by the pure liquid vapor pressure of the least volatile component removed, just as though the other components were not present.

This relationship gives us a good test of stripping column efficiency, for if the absolute pressure on a given system is reduced by, say 20 per cent. then the quantity of steam required for effecting a given degree of stripping of any particular fat oil should also be reducible by approximately 20 per cent.

For the special case analyzed by Lewis and McAdams, it was assumed that the volatile component was dissolved in a totally non-volatile liquid. If such were the case in the modern absorption plant, then the vertical still would consist only of an adequate stripping section. However, experience has proven that the best absorption oil is a partially volatile material which yields heavy overhead fractions from the stripping column. That is, during the stripping operation, some of the light ends of the absorption oil are carried overhead along with the natural gasoline vapors, requiring the addition of a fractionating section to the still for the removal of these heavier fractions from the finished gasoline.

This fractionating section of the still operates similarly to any other temperature controlled fractionating column, in that it washes out the undesirable heavy components from the vapors through the inter-action obtained between an ascending stream of relatively hotter vapors and a descending stream of relatively colder reflux material. This reflux may be obtained either from a reflux condenser operating on the overhead vapor stream, or from a cold spray of gasoline obtained from the receiving tank. In either case, the resultant reflux action cools the upper portion of the column, thus producing a substantial temperature gradient between the top and bottom trays of the fractionating section.

This temperature control constitutes one of the principal differences between the fractionating and stripping sections of the still—for, whereas, in the fractionating sections, we must maintain this temperature gradient, in the stripping sections, the best results are obtained when all such temperature gradients are suppressed.

Special Conditions

Although the absorption gasoline still fractionating section is similar to the general run of conventional fractionating columns, it must cope with a special set

(Continued on page 76)

Cracking Survey

In addition to the cracking units included in the accompanying discussion and tables, late advices from a manufacturer give the following information, which is presented here, since it, too, indicates that interest in the development of liquid phase cracking is not lacking.

In addition to the four Jenkins units listed in table No. 2 the following capacity has been contracted for:

Burford Oil Company, Pecos, Texas	1 Jenkins unit	—1,500 barrels
Rio Grande Oil Co., Los Angeles	2 Jenkins units	—1,500 barrels
Hercules Gasoline Company, Los Angeles	1 Jenkins unit	—1,500 barrels
Total	4 units	4,500 barrels

A recent survey of liquid phase cracking installations indicates that interest and development of this phase of petroleum refining is not lagging to the extent commonly believed by many in the industry who have not studied the current situation.

While there is no concerted effort upon the part of the industry to push to completion a large number of cracking plant installations comparable to the extensive work done some three years ago, there is, however, a continued steady growth and development of the cracking art, accompanied by the installation of numerous cracking units of various types in the many refining centers of the world.

Information secured from the manufacturers and marketers of the five leading cracking processes, including Cross, Tube and Tank, Holmes-Manley, Dubbs and Jenkins, and compiled in tabular form and accompanying this discussion, is an attestation to the fact that the industry is still spending some millions of dollars in the installation of liquid phase pressure processes for increasing the recovery of gasoline from the barrel of crude.

Recent Installations

A total of 25 cracking units, ranging in capacity from 1000 to 3000 barrels daily, were placed in operation during the past six-month period. The total capacity of this equipment is 53,100 barrels.

During the year 1927 The Texas Company led all others in the number of cracking units installed in its own refineries. At Port Arthur this company installed 18 units of the Holmes-Manley process, two went in at the Dallas, Texas, plant, and two at West Tulsa, Oklahoma, making a total of 22 units during that year, and bringing the company's total units to 102. This data comes from the company's annual statement.

Of the 25 cracking units listed in Table 1, two Holmes-Manley installations completed and placed in operation in October, 1927, are included for the reason that they were not included in previous surveys published in this magazine last June. The units in question are those of the Utah Refining Company at Salt Lake City, and the Standard Oil Company of Kansas at Neodasha. The Dubbs installation of two 2500-barrel units at the Oil City, Pennsylvania, plant of The Pennzoil Company, completed before the first of this year, are included in the table for the same reason.

Of the 25 units placed in operation during the period mentioned, six were processing oil in foreign countries. One unit of Cross process of 1000 barrels capacity was completed in Patagonia, for the Cia Ferrocarrilera de Petroleo, and five units of the Dubbs process were ready for operation in Canada (1 unit); Curasao, Dutch East Indies (2 units), and Campania, Roumania (2 units). Total foreign capacity placed in operation during the period was 12,200 barrels.

The remaining 19 units of the vari-

TABLE 1
INSTALLATIONS PLACED IN OPERATION LAST SIX MONTHS

Company and type of process—	Location—	Units	Unit Size—Bbls.	Total Capacity Bbls.
Cross				
Barber Asphalt Co.	Perth Amboy, N. J.	1	2,000	2,000
Cia Ferrocarrilera de Petroleo	Patagonia	1	1,000	1,000
Standard Oil Company of New York	Buffalo, N. Y.	2	1,000	2,000
Standard Oil Company of New York	Greenpoint, N. Y.	2	2,000	4,000
Waverly Oil Works	Coraopolis, Pa.	1	2,000	2,000
Barnsdall Refining Co.	Okmulgee, Okla.	1	1,000	1,000
	Total	8	.....	12,000
Tube and Tank				
Humble Oil and Refining Company	Baytown, Texas	2	2,700	5,400
	Total	2	.....	5,400
Holmes-Manley				
Utah Refining Company	Salt Lake City (Oct., 1927)	2	2,000	4,000
Standard Oil Company of Kansas	Neodasha, Kan. (Oct., 1927)	1	2,000	2,000
	Total	3	.....	6,000
Dubbs				
British-American Oil Refining, Ltd.	Toronto, Ont., Canada	1	1,200	1,200
Empire Refineries, Inc.	Ponca City, Okla.	2	3,000	6,000
Empire Refineries, Inc.	Gainesville, Texas	2	3,000	6,000
Curacosche Petroleum Industrie Maatschappij	Curacao, Dutch West Indies	2	2,000	4,000
Pennzoil Company	Oil City, Pa.	2	2,500	5,000
Steaua Romana	Campania, Roumania	2	3,000	6,000
	Total	11	.....	28,200
Jenkins				
Western Oil & Refining Company	Los Angeles, Calif.	1	1,500	1,500
	Grand Total	25	.....	53,100

ous processes reported as starting operations recently are all in the refining centers of the United States. The total capacity for these new United States units is 40,900 barrels. Companies and districts where such units were placed in operation are shown in Table 1.

Construction of New Cracking Units

The present survey shows that the status of construction of cracking units throughout the world is as follows: Thirty-four units are now building, with a total capacity rating of 60,700 barrels. Of these 34 units, 18 are being erected in foreign countries. A second Cross unit is building for the Cia Ferrocarrilera de Petroleo, in Patagonia. Standard Oil of New Jersey is erecting two 2000-barrel units of Tube and Tank process at Fawley, England, and one 1000-barrel unit at Bahia Blanco, Argentina, S. A. Raffineria de Olii Minerali Societa Anonima has under construction at Fiume, Italy, one 1000-barrel unit of the Holmes-Manley process. Dubbs cracking units are being installed by De Bataafsche Petroleum Maatschappij at Balik Papan, Borneo, Dutch East Indies, where six units of 1000-barrel capacity are going in, and the same company is installing one 1000-barrel unit at Tjepoe, Java, Dutch East Indies. Burmah Oil Company, Ltd., at Rangoon, India, has under construction one 1500-barrel unit, and Aquila Franco Romana is installing one 1000-barrel unit at Ploesti, Roumania. Four 1000-barrel Dubbs units are being erected by Curacaosche Petroleum Industrie Maatschappij in Curacao, Dutch West Indies.

The remaining 16 liquid phase cracking units now under construction are being erected at various points in the refining districts of the United States. The total rated capacity of the units under construction in this country is 40,200 barrels. These figures indicate that the present trend in this country in the construction of such equipment is toward the larger unit of greater through-put capacity. Standard Oil Company of Louisiana is expanding its cracking facilities at Baton Rouge, Louisiana, through the installation of two 2600-barrel Tube and Tank units. The Texas Company has one Holmes-Manley 2000-barrel unit under construction at its plant at Pryse, Kentucky. Standard Oil of California has nine 1000-barrel Dubbs units going in—one at Richmond, and eight at El Segunda. Jenkins units are being installed by the Tri-State Refining Company, Kenova, West Virginia; Western Oil Corporation of California at Wilmington, California; Motor Fuel Products Company at Laredo, Texas; and Western Oil Corporation at Duncan, Oklahoma.

Taking the two tables—"Installations Placed in Operation During Last Six Months," table 1, and "Installations Now Under Construction," table 2—and adding the totals it is found that the status of the cracking phase of the refining industry is expanded by a total of 59 cracking units, having a total capacity of 113,800 barrels, which must be added to former surveys.

Cutting Oils—Their Characteristics and Manufacture

(Continued from page 67)

(or rosin oil) and a solution of caustic soda in dilute alcohol. The mixing may take place at ordinary temperature or may better be carried out at a more elevated temperature, if conditions permit, thereby saving time and bringing about a more complete saponification. There is no definite difference between the action of a cold mixed or a boiled soap solution. Solutions of from 45 to 65 per cent. content of soap, in solvents containing from 35 to 55 per cent. alcohol, by weight, have been tried and found satisfactory. It has been found possible to prepare clear and homogeneous oils, readily soluble in water to permanent emulsions from asphaltic base oils as well as paraffine base oils, ranging from water white to Solar Red Oil, by following the schedule of work that has been described earlier in this article. The way of decreasing the formation of films on the surface of exposed soluble Cutting Oils, as well as prevent persistent foaming has also been tried and found, so far, satisfactory.

The following notes may be of assistance when trying to correct an imperfect oil:

1. Oil is turbid and segregates on standing: lack of Elain.
2. Oil is insoluble in water: too much Elain, or too high ratio of mineral oil to solvent.
3. The emulsion separates drops of oil, and does not foam: lack of Elain.
4. The emulsion gives persistent foam and yellow mush: too much Elain.
5. The oil produces a thick film on being exposed to the air: sodium oleate has been used. The solvent contained in the oil has too high contents of alcohol. Unnecessarily high ratio of solvent.

TABLE 2
INSTALLATIONS NOW UNDER CONSTRUCTION

Company and type of process—	Location—	Units	Unit Size—Bbls.	Total Capacity Bbls.
Cross				
Cia Ferrocarrilera de Petroleo	Patagonia	1	1,000	1,000
	Total	1	.....	1,000
Tube and Tank				
Standard Oil Company, N. J.	Fawley, England	2	2,000	4,000
Standard Oil Company, N. J.	Bahia Blanco, Argentina	1	1,000	1,000
Standard Oil Company, Louisiana	Baton Rouge, La.	2	2,600	5,200
	Total	5	.....	10,200
Holmes-Manley				
The Texas Company	Pryse, Kentucky	1	2,000	2,000
Raffineria de Olii Minerali Societa Anonima	Fiume, Italy	1	1,000	1,000
	Total	2	.....	3,000
Dubbs				
Aquila Franco Romana	Ploesti, Roumania	1	1,000	1,000
De Bataafsche Petroleum Maatschappij	Balik Papan, Borneo (Dutch East Indies)	6	1,000	6,000
De Bataafsche Petroleum Maatschappij	Tjepoe, Java (Dutch East Indies)	1	1,000	1,000
Burmah Oil Company	Rangoon, India	1	1,500	1,500
Curacaosche Petroleum Industrie Maatschappij	Curasao (Dutch West Indies)	4	1,000	4,000
Standard Oil of California	Richmond, Calif.	1	3,000	3,000
Standard Oil of California	El Segundo, Calif.	8	3,000	24,000
	Total	22	.....	40,500
Jenkins				
Tri-State Refining Company	Kenova, West Va.	1	1,500	1,500
Western Oil Corporation of California	Los Angeles, Calif.	1	1,500	1,500
Motor Fuel Products Company	Laredo, Texas	1	1,500	1,500
Western Oil Corporation, Oklahoma	Duncan, Okla.	1	1,500	1,500
	Total	4	.....	6,000
	Grand Total	34	....	60,700

Corrosion Prevention in High Pressure Plants and Heating Systems*

By R. A. BOYD
Assistant Superintendent Columbian Gasoline Corporation

THERE are two groups of factors controlling corrosion in boilers. One is the tendency of the metal to go into solution, this initial corrosion being maintained by the depolarizing effect of free oxygen and by the acidity of the water.

The second group is the protective coatings deposited on the metal by the water, the polarizing effects of hydrogen in the absence of oxygen and the alkalinity of the water.

All natural feed waters contain solids which come from the earth and will form scale, some water even having so much solids or acids that they are unfit for boiler water.

However, a light scale which is formed by some water is beneficial in the prevention of corrosion.

Straight rain water is corrosive due to its acidity, high oxygen content, and lack of matter to form a protective coating.

A steam boiler is a fairly efficient degasifier where evaporation is going on at a normal rate. However, regardless of the theory of corrosion, dissolved oxygen in feed water is responsible for most of corrosion to boiler, piping and machinery.

Carbon dioxide in small amounts will have very little effect on boiler corrosion, but may cause rapid corrosion to steam turbine blading, and other steam auxiliaries.

Boiler Scale

Experience shows that water containing sodium chlorides alone is not corrosive to boilers, but water containing magnesium chloride is, and is of a regenerative nature and corrosion will continue in cycles.

Acid boiler feed water is usually derived from industrial waste, swampy land, or magnesium chloride.

Sulphuric acid may be generated in a boiler, the feed water of which has been treated with alum, unless sufficient alkali is added to form stable sulphates.

Another course of acidity is from animal fats derived from lubricating oils.

Excessive boiler scale is objectionable in several ways as well as dangerous. However, a thin scale is really beneficial to the metal of the boiler. A thin scale can be maintained in a boiler using water that will not scale by the addition of small amounts of calcium hydroxide. This treatment should not be used unless the boiler water is tested daily by a competent man in this line of work.

Organic matter is not always corrosive, especially where it is very high, due to it absorbing the oxygen from the water.

Hydrogen embrittlement sometimes occurs in boilers using a water high in sodium carbonates, or containing caustic soda. It is thought that these substances become concentrated at points where the circulation is poor in the boiler and cause the metal to crack. However, sodium carbonate is used in boiler feed water to break up the scale forming sulphates, and retard or prevent the action of caustic soda.

Chemical Prevention

The practice of boiler feed water treatments by chemicals is widely practiced. This consists largely in introducing some chemical or chemicals that will precipitate the permanent hardness, either before or after the water enters the boiler.

It is much more preferable to treat the water before it enters the boiler, especially high pressure boilers, but very good results can be obtained treating the water in the boiler below pressures of 150 pounds.

There are various systems of treatment. The lime treatment is used to fix the free and hard bond carbon dioxide in water containing bicarbonates of lime and magnesia. Soda ash treatment is used mainly with water containing sulphates of lime and magnesia with little or no carbonic acid or bicarbonates. It reacts with the sulphates to form and precipitate the insoluble carbonates of lime and magnesia. Lime, soda ash treatment is the most widely used, as both the sulphates and bicarbonates of lime and magnesia are removed.

Treatment of boiler water may also be accomplished by mixing two or more waters.

In any treatment where chemicals are used the water should be analyzed and the proper treatment prescribed for that particular water.

Corrosion in steam turbines is sometimes very rapid due to impure steam or condensation of the turbine and the infiltration of air.

Electroytic action in boilers usually causes pitting and can sometimes be overcome by contact between the boiler plates and slabs of zinc, or by imposing an external electromotive force on the surface to be protected. However, externally applied current is very difficult as it is hard to distribute the current evenly.

Some users of boilers give them special treatments of lime when they are new or when tubes are installed to form a light scale on the new metal. This treatment usually extends over a period of six days and consists of administering about 10 pounds of lime for each 30,000 pounds of water while it is cold, run in through the man hole and then from four to six pounds of lime for each 30,000 pounds of water is fed in through the hot well.

Hot Water Systems

Pump glands should be kept tight to prevent air from being drawn in.

Boilers should be blown often enough to keep concentration of suspended matter to a minimum.

Corrosion in hot water heating systems is caused largely by dissolved oxygen in the water, and often conditions similar to those encountered in steam boilers.

Also the factors applying to under water corrosion are to be considered.

However, in hot water systems the scale problem is very much more simple due to the small amount of makeup water which has to be added.

If heating systems are kept tight the oxygen that is put into the system soon unites with the metal to form rust and the action from oxygen stops. Iron, however, continues to be dissolved very slowly in oxygen free water with the liberation of hydrogen gas.

Carbon dioxide and other gases are the ones to be dealt with in hot water heating systems. To prevent corrosion in these plants the water should be made slightly alkaline with caustic soda or lime when the system is first filled and the water should not be drawn from the system at any time unless absolutely necessary.

Occasionally the inside of lines should be examined and if corrosion is found steps should be taken to ascertain the cause and proper steps under proper laboratory advice taken to eliminate the cause.

*Paper presented before foremen's meeting of the Columbian Gasoline Corporation.

Shreveport P. & R. Making Improvements

LATE improvements in plant equipment at the Jewella (Shreveport) Louisiana, refinery of the Shreveport Producing & Refining Corporation, consists of the installation of two large bubble type fractionating columns. One bubble tower was installed in connection with a shell still through which pressure distillate is redistilled, while the other and larger tower was placed in the line of crude stills, for the purpose of effecting better separation between the gasoline and kerosene fractions. Through the operation of this tower the company has secured a yield running from 15 to 16 per cent gasoline stock from Smackover crude oil and in addition to increasing the percentage recovery from around 13 per cent., a better or more uniform and well balanced product is the result with an appreciable increase in plant capacity.

In the operation of this plant the crude oil passes in counter-current flow to the hot residuum from the last still through the usual interchange equipment. One separator chamber is included, placed between the two exchangers, where salts and other foreign matter as customarily occurring in Smackover oil, is settled out. Crude temperature leaving the exchanger equipment is around 250 degrees as it enters the first still. The flow then proceeds through the first three stills where gasoline fraction are removed. Leaving the third still the gravity crude flow is interrupted and the battery of continuous stills broken by the insertion of the large bubble type fractionating column.

This installation effects the removal of the heated oil in the third still upward and into the middle section of the bubble tower by employing the familiar steam jet, instead of transferring from still to tower by pump. The steam jet has been employed more or less successfully in the transfer of oil for short distances in the refining industry for many years. For a time prevailing practices disregarded its use, but during the past few years a great many refineries have again taken advantage of the jets positive action and economy of transfer for moving oil from still to still or from still to tower.

In the installation the oil flows from the still in the usual manner and overflows into a descending pipe downward a few feet below the base of the tower. Something of the details of this installation are shown in the accompanying photograph. The descending line on the left side conveys the hot oil into a pit, where a small steam line is inserted just as the bend starts upward. The line on the right side conveys the oil up and into the tower. Note that the block valve is provided up a few feet from the bottom of the "U' bend, so that there is always a column of oil lying above the steam jet. When the plant is shut down the oil level is above the jet, so that upon resumption of operation the flow is started easily by opening the jet.

Recycling

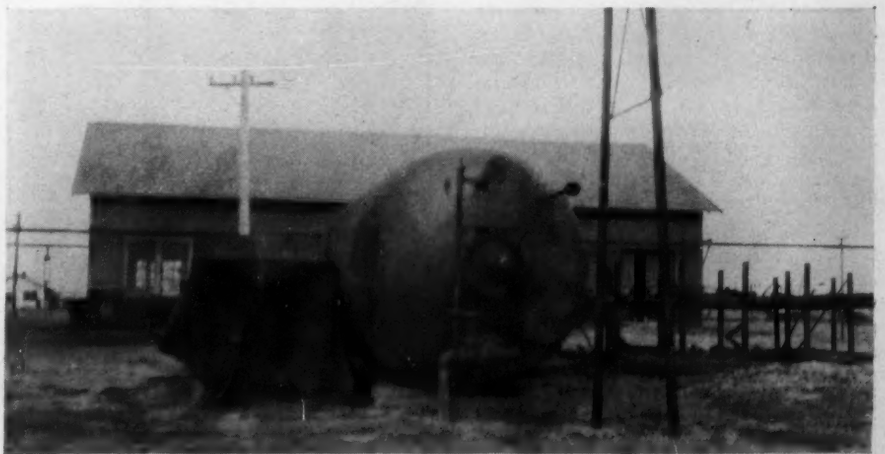
This partially denuded crude oil is recycled through the lower compartment of the tower, flowing downward over the numerous bubble trays, and returning to the fourth still in the battery through the reflux line. Vapors from the fourth still rise counter-current through the descending oil and through the scrubbing secured by this intimate contact, closer fractionation is secured. The tower operation is controlled by automatic temperature control instruments governing circulation of cooling media through a closed coil in the uppermost compartment of the tower. The new fractionation equipment is the design of Winkler and Koch Engineering Company.

The remaining shell stills in the battery produce the heavier fractions of kerosene which is chemically treated and marketed, and gas oil which is utilized as charging stock for the Jenkins cracking unit. In the operation of the Dubbs cracking units fuel oil is used as charging stock.

The Shreveport Producing & Refining Corporation has installed a safety conveyor leading from the top of their Dubbs units, at the lower platform of the dephlegmators, to the ground, which provides an avenue of escape for men employed in repair or maintenance work. In several instances in the past, in the refining industry, employees working in the top of the tower have been trapped by flames breaking out in the lower section of the cracking unit which cut off their means of escape. With the cable conveyor the hazard is reduced. As the first man leaves the tower, descending to the ground in a saddle, a second empty seat is returned to the top of the tower along the guy line, so that the other men employed at the top of the dephlegmators may swiftly ride to the ground. It is possible for three men to make a safe descent from the high platforms to a point of safety about 100 feet away in two minutes.

Old Equipment has Use

The Shreveport organization has adapted discarded Dubbs unit expansion chambers to other uses about the plant. Many of the older type of Dubbs cracking units have been improved through the installation of new and larger expansion chambers, which has resulted in a number of these heavy steel vessels being discarded in the past few years. They have been put to a number of uses in the refining industry, some operators using them in their continuous treating system where they act as settling basins for the separation of oils and chemicals. In this case, however, the company needed a combination surge tank and a scrubber for handling the uncondensible vapors and gases derived from the operation of the cracking units. The accompanying photograph illustrates the manner in which one of the old Dubbs



Discarded cracking unit expansion chamber utilized as a compressed air reservoir, centrally located on the plant site and close to the cracking units and machine shop where compressed air is most frequently required.

Gas reservoir and surge tank made from an old cracking plant expansion chamber

expansion drums was converted into a gas holder. The three lines shown leading into the gas surge tank convey the permanent vapors from each of the cracking units. Any condensate passing over with the gas is collected and removed here. When the vapor recovery plant is installed these gases will first pass to the absorption plant, where they will be stripped of the gasoline content, and then conducted to this large surge chamber, from which they are directed to the furnaces for consumption as fuel.

A second photograph shows another expansion chamber in service as a centralized storage tank or reservoir for compressed air. Air is discharged into this tank from a small compressor near the tank.

The small compressor is in reality an auxiliary unit, being used only when the large steam compressor at the agitator is not required for treating purposes. This larger compressor is Ingersoll-Rand 10 by 14 steam; 16 by 14, air in size. The machine discharges into the air reservoir, at the desired pressure, from where it is conducted to the point of service. This reservoir assures a steady flow of air at constant pressure. In cleaning out tubes after each run, this compressed air is necessary for driving the vibrating cleaners. It is also required for driving air hammers, etc., such as are commonly used around the plant in repair work. The "air tank" is located in about the center of the plant yard, and close to the machine shops and cracking units, which two departments require air under pressure more than other part of the plant.

The Shreveport Producing & Refining Corporation contemplates enlarging its refinery in the near future, increasing the capacity, and the installation of a 5,000 barrel pipe still and conjunctive fractionating equipment. Included in the program of expansion is the installation of a modern vapor recovery plant which will extract the gasoline components from gases from the cracking units and from the vapors derived from receiving house and light oil storage tanks.

BURFORD COMPANY PLANT

Shreveport, La. — The Burford Oil Company has started construction work on a 5,000 barrel daily capacity skimming and cracking plant at Pecos City, Texas, to operate on West Texas crudes, and is scheduled to begin operating September 1, 1928.

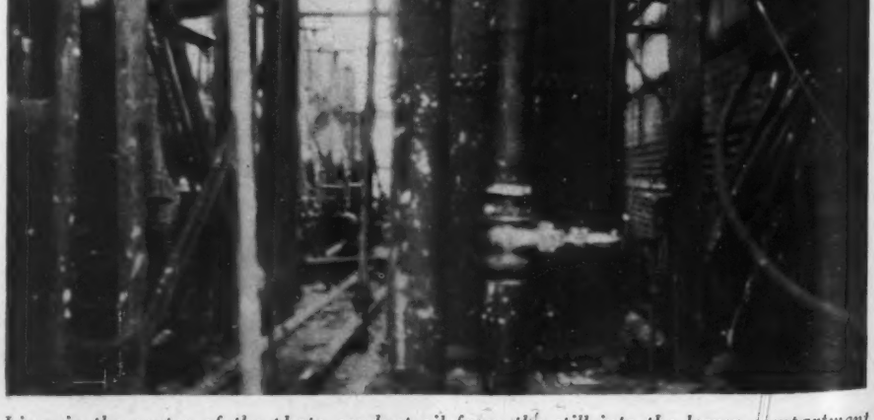
The Burford Oil Company was organized in May to engage in the refining and marketing business, with 200,000 shares of no par stock issued and fully paid in. The executive offices of the company are located at Shreveport, and Texas headquarters will be at the Pecos City plant. Officials of the Crystal Oil Refining Corporation, which has two plants in operation at Shreveport, will manage the affairs of the Burford Oil Company. G. L. Estabrook, of Philadelphia, president of Crystal and member of the firm of E. W. Clark & Company, is chairman of the board of directors of the Burford Oil Company. F. W. Burford, vice-president and general manager of Crystal, is president and general manager. J. J. Thomas, who has been superintendent of refineries for Crystal, has been appointed superintendent of the Pecos City plant, and will move there July 1.

The Graver Corporation, Chicago, has been given a turn-key contract to erect the Pecos City plant, which is expected to cost $650,000, including tankage. A Jenkins cracking unit type No. 5, with a throughput of 1,750 barrels daily, will be used in connection with this plant. Special equipment has been ordered to enable this plant to manufacture all grades of gasoline conforming to the specifications of the United States Bureau of Standards, thus affording an opportunity to take on export business along with domestic sales. The plant site is situated so that tank car shipments can be made over the Texas & Pacific and Santa Fe Railroads.

A 40-mile six-inch pipe line is being constructed by The Skelly Oil Company and the Burford Oil Company from the former's proven leases in the Hendrick field, Winkler County, Texas, and this line will supply the plant with crude. The crude handled by this line in excess of the refinery requirements will be shipped to distant refining centers in tank cars, while Skelly Oil Company is favored with a one-line haul from Pecos City via the Santa Fe Railroad to its El Dorado, Kansas, plant. Crystal also contemplates moving some crude from the Pecos City terminal via the Texas & Pacific Railroad to its Shreveport plants.

REVISE PETROLEUM TESTS

Atlantic City.—In connection with the thirty-first annual meeting of the American Society for Testing Materials, there will be held here on June 27 the annual meeting of Committee D-2—petroleum products and lubricants—of the American Petroleum Institute. Subjects which will come up for consideration will include the new methods of test for crude petroleum, determination of autogenous ignition temperatures, gravity of petroleum by means of hydrometer, and new definitions relating to petroleum.



Lines in the center of the photo conduct oil from the still into the lower compartment of the bubble tower. Transfer is made by steam jetting. Valve is placed in the ascending line above the steam jet. Oil flows into the jet by gravity through the overflow line from the still. Oil is returned to the still battery through the reflux line from the bottom of the tower.

Safety for the "Gauger"

THE "gauger" has a hazardous job. His work, which involves climbing to the roofs of tanks of all sizes, must be done in rain, in freezing weather often accompanied by blizzards, and often in darkness. And regardless of the climatic conditions his reports must be accurate.

When safety engineers inspect the refinery and the tank farm, one of their first thoughts is that of protecting the man who must climb steep steel ladders in all sorts of weather to the tops of these tanks, and perch precariously upon its edge for some minutes while measuring the contents. Some proponents of the safety move advocate that the gauger be given a helper, a sort of guardian, because of the hazardous nature of his work. This policy even extends to the organizations which have either provided safety guard rails surrounding the gauge hatches, or have moved the gauge hatches close to the edge of the tanks within easy reach of the gauger standing upon the last platform of the steel steps.

In the accompanying photograph the method of making big tanks safe, as employed by the Empire Refineries, Inc., is shown. This pipe fencing encloses an area of the tank's top amply large for the gauging operation. The framework of one-inch pipe, of which the guard rails are made, comes from the welder's shop, and is made from the scrap material about the plant yard. The safety "fence" is then spot-welded to the tank top at some time when the tank is not full of oil. With the double guard rails as shown, it is easy to prevent a fall when the tank tops become covered with a thin, slippery coating of ice during the winter days.

The gauger's assistant is to be recommended, even when tank tops are protected by the safety fencing. Many operators insist that no man gauge the larger tanks alone, especially during winter or wet weather, or darkness.

Standing on the slanting roof of a big tank a gauger has to be somewhat of a juggler even when conditions are at their best. With an assistant or helper, his work is simplified, and usually the time required to measure a given number of tanks is appreciably reduced.

During night gauging the helper handles the flashlight—an important adjunct during darkness, but an obstinate device that usually rolls around, is blown by the wind, and "won't stay" between the knees. The gauger must have two hands to handle the steel line. The lantern type flashlight is recommended for this work, since it can rest on the tank top or may be hung on a cord around the gauger's neck. It is far better, however, to provide the helper to handle the light. Then there are the wiping rags for cleaning the tape, and the chalk for marking the tape in light oil gauging. The thermometer for getting accurate temperature of the oil, and often the thief, or other "water gauge" devices—and the cold and "biting" steel line for gauging—all these instruments concurrent to accurate gauging become real sources of annoyance when a high wind, bearing cold rain, on a dark night, constitute the conditions under which the work must be done.

Additional reason for the "helper" lies in the fact that men become gassed on occasion when working on light oil tanks under certain weather conditions. A man may gauge a tank three times in one morning and seemingly thrive on the vapors he breathes—then eat something for lunch which places his system in the right condition to become easily gassed, dizzy and sick, when he measures the same tank in the afternoon. A gauger's helper at 50 cents an hour is not a bad investment under such working conditions—and the safety fence at a cost of a few dollars per tank is necessary to protect them both.

LARGEST GASOLINE PLANT

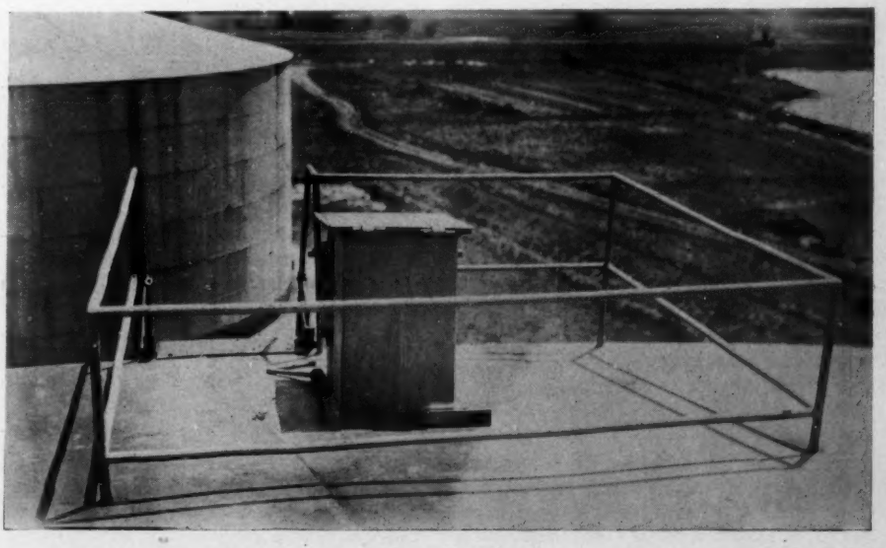
Amarillo, Texas.—As part of an extensive building program in the Panhandle district, the Phillips Petroleum Company is building a new type gasoline plant in Section 22, Block Y. M. & C. survey, Hutchinson County. It will handle 60,000,000 cubic feet daily of lean gas, making it probably the largest plant in the Mid-Continent area; and will be designed especially to meet conditions peculiar to the Panhandle district. The plant will operate on the well pressure system, through which capital investment and operating cost are practically eliminated, as there is no necessity for engines for pulling vacuum and for compression.

To operate a plant of this kind requires a large volume of gas, and so the gas is taken from a large area; and all the equipment is on a large scale.

Besides this plant, the Phillips Petroleum Company will construct two other new plants and enlarge one plant already in use. One of the new plants will be known as the Sanford plant, and was to be operating about June 1. It is in Section 82, Block 46, H. & T. C. Ry Survey, Hutchinson County. Its capacity will be around 20,000,000 feet of gas daily. The other new plant will be the Texroy plant, which will have about twice the capacity of the Sanford plant. It will be in Section 4, Block B-3, D. S. E. R. R. Survey, Hutchinson County, in the McIlroy pool. The Pampa plant in Section 82, Block B-2, Gray County, in the Bowers oil pool, is the one that is being enlarged. Through installation of an additional unit, an exact duplicate of the present plant, the capacity of the plant will be doubled, making it 30,000 gallons daily.

EXPLOSION KILLS FIVE

Muskogee, Okla.—At Pure Oil Company's experimental plant here there was an explosion on April 28 which resulted in the death of five men, through burning oil being scattered. The casualty list included O. L. Loving, yard foreman; R. G. Tucker, chemist; James W. Lyons, mechanical engineer; A. W. Hutchison, distillation engineer; and George Eaton, still foreman. The explosion was not serious from the standpoint of damage to equipment.



"Safety Fence" surrounding the guage hatches on all large tanks at Emipre Refineries, Inc., plants.

The Vertical Steam Still as Applied to Fat Oil Distillation Service

(Continued from page 69)

of conditions not found in the usual fractionating unit, namely:

(1) The volume ratio of ascending vapors to descending liquid in the fractionating section is very large. This large ratio requires that special attention be given to obtaining good distribution of the reflux over the fractionating trays, since each small particle of reflux oil must be brought into intimate contact with a very large volume of vapor at each fractionating plate.

(2) In our discussion of the stripping operation we brought out the fact that steam leaving the stripping section can only be partially saturated. This means that the vapors entering the fractionating section are superheated and that the first few trays of this unit act simply as cooling and reboiling trays rather than as fractionating trays. In other words, on the lowest trays of the fractionating section, lighter fractions are being boiled out of the descending reflux and superheat is being extracted from the ascending vapors without the effecting of a corresponding condensation of heavy fractions from these ascending vapors.

Now this reboiling effect is not at all an unmitigated evil, since it produces an exhausted reflux for the stripping column; however, it does require more plates in the fractionating column than would otherwise be necessary for removing the undesirable heavy ends from the overhead gasoline cut.

Right here the question will be asked: "How is it that even though the steam leaving the stripping column at some temperature Tx was carrying all the light fractions it could, we now find it picking up more light material in the fractionating column at a temperature lower than Tx?" "Raoult's law" is again the answer. The concentration of gasoline fractions in the reflux liquid on the lower fractionating trays is much higher than it is in the absorption oil on the upper stripping trays. Consequently, the partial pressure of these gasoline fractions is also much higher on the lower fractionating trays. This higher vapor pressure, in turn, makes it possible for gasoline fractions to continue to migrate out of the liquid into the ascending vapor stream.

(3) The quantity of steam being handled along with the stripped gasoline vapors in the fractionating section is usually so large that some of it must be condensed out in the fractionating column proper before it is possible to furnish a reflux oil to the lower fractionating trays. This water cut is obtained automatically through the cooling effect of the reflux spray or reflux condenser—but the handling of the condensed water is not so simple a matter. The usual solution is to bleed the water off from an intermediate fractionating tray or from the bottom of the fractionating column. In a properly designed unit, this water bleeding will cause little trouble, but in a poorly designed column it may be a constant source of annoyance.

In closing, we would emphasize the fact that a high steam rate costs you money, whichever way you turn. We often hear the expression that "steam is cheap," or that "it costs us nothing because it is exhaust steam." However, every additional pound of steam used in a still requires just that much more condensing surface, along with additional condensing water, and additional cooling tower capacity. Also, it is the steam volume that determines the necessary size of the still equipment. Hence, good engineering calls for intelligent design looking toward maximum steam economy.

We would also again call to your attention the fact that the laws and reactions outlined in this paper apply exactly only to special theoretical cases. However, the same tendencies exist in all absorption plant operations, although the exactness of the application of these laws in the latter case may be disguised due to the complexity of the materials being handled.

EDITOR'S NOTE—The process of removing water from the fractionating column is fully covered by patent applications.

W. P. R. A. Committee Named

Tulsa, Oklahoma.—Committees for the Western Petroleum Refiners' Association for 1928 have been announced. The appointments were made following the annual meeting in Kansas City, Missouri, March 7.

The committees follow:

Manufacturers

L. R. Crawford, chairman, Producers & Refiners Corporation.

R. A. Frevert, Lubrite Refining Company.

H. W. Camp, Empire Oil & Refining Company.

Walter Miller, Marland Refining Company.

J. M. Wadsworth, Independent Oil & Gas Company.

Dr. E. R. Lederer, Texas Pacific Coal & Oil Company.

C. R. McKay, Pierce Petroleum Corporation.

F. E. Wellman, Manhattan Oil Company.

W. F. Simms, Panhandle Refining Company.

F. E. Holsten, Barnsdall Refineries, Inc.

Dr. F. W. L. Tydeman, Roxana Petroleum Corporation.

B. P. Crittenden, Louisiana Oil Refining Corporation.

M. E. Foster, Phillips Petroleum Company.

R. J. Black, Sinclair Refining Company.

R. C. Osterstrom, Pure Oil Company.

C. R. Barton, Tidal Refining Company.

Finance

E. W. Goebel, chairman, Manhattan Oil Company.

Geo. D. Locke, Barnsdall Refineries, Inc.

M. J. Grogan, Louisiana Oil Refining Corporation.

Traffic

F. A. Pielsticker, chairman, Skelly Oil Company.

A. C. Holmes, Empire Oil & Refining Company.

F. H. Walker, Shreveport Producing & Refining Corporation.

B. J. Burchett, Shaffer Oil & Refining Company.

E. W. Sieboldt, Roxana Petroleum Corporation.

A. F. Winn, Skelly Oil Company.

L. R. Cowles, White Eagle Oil & Refining Company.

Credit and Accounting

R. R. Irwin, chairman, White Eagle Oil & Refining Company.

Emery Burnett, Continental Oil Company.

W. Z. Brown, Producers and Refiners Corporation.

M. D. Creel, Marland Refining Company.

J. M. Judson, Sinclair Refining Company.

F. H. Bowman, Pure Oil Company.

M. W. Bottomfield, Transcontinental Oil Company.

M. A. Chambers, Panhandle Refining Company.

H. M. Edinger, Barnsdall Refineries, Inc.

Chas. Klein, Mid-Continent Petroleum Corporation.

A. J. Ahlum, Crystal Oil Refining Corporation.

Marketing

R. R. Irwin, chairman, White Eagle Oil & Refining Company.

D. W. Moffitt, Mid-Continent Petroleum Corporation.

J. B. Atkins, Shreveport Producing & Refining Corporation.

John McE. Ames, Kanotex Refining Company.

C. L. Henderson, Vickers Petroleum Company.

G. W. Reed, Panhandle Refining Company.

L. R. Crawford, Producers & Refiners Corporation.

Legislative

P. M. Miskell, chairman, Empire Oil & Refining Company.

J. C. Denton, Mid-Continent Petroleum Corporation.

E. W. Goebel, Manhattan Oil Company.

Frank M. Smith, Oriental Oil Company.

D. P. Hamilton, Root Refineries, Inc.

Membership

Geo. D. Locke, chairman, Barnsdall Refineries, Inc.

F. W. Burford, Crystal Oil Refining Corporation.

John L. Gray, Shaffer Oil & Refining Company.

A. F. Garrett, Tidal Refining Company.

E. D. Levy, Pierce Petroleum Corporation.

Motor Fuel Theme of Natural Gasoline Convention

Tulsa, Okla.—Natural gasoline as a motor fuel might well have been the theme for the program of the seventh annual convention of the Natural Gasoline Association of America. While the several papers dealt chiefly with technical phases of natural gasoline, in most of these the question of a finished fuel was given consideration.

The convention was held here May 22, 23 and 24. The program was confined to two days, leaving the third for a visit to the Seminole area, which has drawn the greater portion of natural gasoline plant building in the past year.

In his annual address, H. A. Trower, president of the association, spoke on the selling of natural gasoline as finished motor fuel as follows:

"As to the outlook for the natural gasoline industry for the coming year, we can feel reasonably assured that the worst effects of the recent period of over-production are ended. Both crude oil and natural gasoline production have remained constant for several months. As a matter of fact, natural gasoline production has declined slightly.

"Such factors point to better prices for motor fuels and natural gasoline. One of the most significant trends in the natural gasoline industry is found in the fact that more companies are marketing, direct, both aviation and motor fuels of natural gasoline. One of the most significant trends in the natural gasoline industry is found in the fact that these efforts will undoubtedly create wider markets for natural gasoline, with a resultant stimulation in prices. Another very significant factor is to be found in the interest which jobbers are manifesting in natural gasoline as a blending component in their business. This interest can be directly traced primarily to the excellent work of Dr. G. G. Brown, research director for the association. Several of the larger companies have been very active in utilizing the information made available by the association's research program.

New Markets

"These are healthy symptoms for the natural gasoline industry. Heretofore a single market has been relied upon. In connection with these new markets, a word of caution is not out of place. The natural gasoline that is marketed to the public more directly than ever before, should be carefully and thoroughly investigated as to its satisfactory performance in the field for which it is intended. We all recall the odium which natural gasoline has received, due to the experience of the industry in preparing kerosene blends. If all the units of the industry are not cautious in these more direct markets, natural gasoline may easily fall into disrepute. It must not be forgotten that these companies which are now engaged in reaching these direct markets, have spent several years of research and experiment in order to develop their products. Where aviation fuels are being prepared, they are based upon many experiments as to exactly the product that is required. Where finished motor fuels are being marketed, the utmost care is being used in selecting both the natural gasoline and the blending stock. Where jobbers are being urged to use large quantities of natural gasoline, every precaution is observed to insure that the finished motor fuel will not be unsatisfactory to the public. These are precautions, which are dictated by good business judgment and all of us should keep them in mind.

H. A. TROWER, *President*

By-Product Research

"Another exceedingly promising feature of the next year is the increasing amount of research work in connection with by-products of natural gasoline and natural gas. This problem has been very much in the mind of the industry during the past year and undoubtedly the next year will witness many developments in this field. The use of lighter fractions of natural gasoline as domestic fuel, and for gas enrichment purposes and in other fields, is bound to strengthen the financial position of the industry."

Mr. Trower called attention to the work of the gas testing committee; plant operators' meetings; the specifications committee; the need for improved gas contracts; favorable changes in freight rates; the research program and other activities of the Natural Gasoline Association of America.

Dr. G. G. Brown, research director of the association, gave his second progress report, which dealt largely with experiments in gas lock. This report will be available for later publication.

Officers Named

H. A. Trower, Phillips Petroleum Company, was elected to serve his second term as president. Other officials were re-elected as follows: S. C. Carney, Roxana Petroleum Company, first vice-president; Dr. E. R. Lederer, Texas Pacific Coal & Oil Company, second vice-president; George L. Ratcliffe, General Petroleum Corporation, third vice-president. A. V. Bourque was re-elected secretary-treasurer.

The report of the gas testing committee, of which George P. Bunn of the Phillips Petroleum Company is chairman, submitted its report with the request that it be submitted to the Bureau of Standards.

The board of directors is chosen by designating company members, which in turn designate an individual of such company to serve as a director.

Three concerns were chosen, which were not represented on the board last

(Continued on page 193)

SEVENTH ANNUAL MEETING OF THE NATURAL GASOLINE ASSOCIATION OF AMERICA, TULSA, OKLAHOMA, MAY 22-23-24

The Volatility of Natural Gasoline*

By G. G. OBERFELL
Research Director Phillips Petroleum Company

THE natural gasoline industry is today suffering a condition of overproduction which promises to extend into the years to come. Most of us are agreed that our present overproduction is due to the ever-increasing competition of cracking stills as well as to the overproduction of crude oil and the increased efficiency of extraction of natural gasoline. The demand for anti-knock gasoline is bringing vapor phase cracking processes into prominence. These processes, when placed on a sound economic basis, will encroach even more seriously on the customary markets for natural gasoline.

There can be no denying that economic conditions are confronting the natural gasoline industry which will call into play the utmost skill on the part of its executives and workers. Our problem a few years ago was, "How much gasoline can we make?" Our problem tomorrow will be, "What kind of gasoline shall we make?" I venture to predict that when the present overproduction of crude oil shall have run its course and cracking processes shall have resumed their forward progress this problem will confront us with clamoring insistence. How will we answer it? What do we know about the kind of gasoline we make? When we describe grade AA as stable gasoline it is positive proof that we know very little about it.

Natural gasoline is like many other things—it seems as if the more we learn about it the less we know. It has always been common understanding that the usefulness of natural gasoline depends on its high volatility. Today we know a great deal more about volatility and its practical effects than we did a few years ago, but who can satisfactorily define the volatility of natural gasoline? Who can say with certainty how much more grade A gasoline can be satisfactorily blended with a refinery product than grade AA? Who can state with a high degree of accuracy how much volatility must be removed from natural gasoline before it can be made a satisfactory motor fuel for direct sale to the public? These are vital questions to the natural gasoline industry in the economic conditions confronting it.

Need Own Method

There will probably always be some discussion as to just what the actual vapor pressure is of complex mixtures such as gasoline. For all practical purposes, a reasonable approximation of the actual vapor pressure such as is afforded by the Beistle-Prather or Reid method will no doubt serve satisfactorily. One thing is certain, our present I. C. C. vapor tension method falls far short of the requirements necessary for a reliable vapor pressure method and therefore can be of no service to the industry in solving the important problem of vapor locking. It therefore behooves us to stop talking I. C. C. vapor pressures and immediately adopt a reasonably satisfactory vapor pressure testing method and incorporate vapor pressure specifications for our product.

Reverting to the comparison of grade A with grade AA gasoline, the decrease in production in changing from the high gravity grade to the low gravity grade probably ranges from 5 to 40 per cent.. What would be the relative demand by refiners for natural gasoline if the entire industry were making grade A gasoline instead of grade AA? Would it be 30 per cent., 50 per cent. or 100 per cent. greater? We can only conjecture. But we know this much. To produce motor fuel blends having the same vapor pressure, 60 per cent. grade A can be used while only 12 per cent. grade AA can be used. The manufacturer of grade AA gasoline when seeking a market for his natural gasoline must find a volume of blending material equal to seven times the volume of his natural gasoline production, while the manufacturer of grade A with a relative production of 70 per cent. must find a volume of blending material equal to only two-thirds of his natural gasoline production. These figures mean that for every fifteen gallons of blending material necessary to create a market for grade AA gasoline only one is required to create a market for grade A gasoline.

It is not to be expected that all natural gasoline is to reach the market as a 60 per cent. blend. For our industry to seek a direct market outlet for its product is not necessarily the ultimate solution of our problems, but that this can be done under conditions which promise its success is one bright

*Before annual convention of the Natural Gasoline Association of America, Tulsa, May 22-23-24, 1928.

S. C. CARNEY
First Vice-President

DR. E. R. LEDERER
Second Vice-President

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ray of encouragement in a situation otherwise bristling with gloom.

In the new order of things that is approaching we will have to equip ourselves with all the information possible about natural gasoline. With the fact fairly well established that natural gasoline has a benzol equivalent ranging between 40 and 60 per cent., our chief problem resides in mastering the relation of natural gasoline volatility to automotive requirements.

Aspects of Volatility

There are four important aspects of motor fuel volatility. These are from the viewpoints of vapor-locking, starting and acceleration, power and consumption, and crankcase dilution. In addition, anti-knock properties are to some extent dependent on volatility. Needless to say these functions are more or less interdependent. In reality, there are but two major aspects of motor fuel volatility. One is the ability of the fuel to reach the carburetor jets substantially unvaporized; the other is the vaporization characteristics of the fuels in the manifold and cylinders. Anti-knock properties depend on the nature of the explosion which takes place when the vaporized fuel has been ignited.

To the natural gasoline industry the ability of the fuel to reach the carburetor jets substantially unvaporized is the most important phase of the volatility problem. Upon the limits established to meet this requirement depend how much and what kind of natural gasoline can be used in the preparation of good motor fuels. The excellent work of Dr. Brown and such investigators as Sligh, Bridgeman, Cragoe, Stevenson, Stark, Wilson and Barnard have defined for us the volatility requirements for ease of starting, acceleration, power, consumption and crankcase dilution. It is noticeable in regard to many of these investigations that the principal object has been to determine the minimum volatility a satisfactory motor fuel may possess. Except for Dr. Brown's work no one has attempted to define the maximum volatility permissible in good motor fuels.

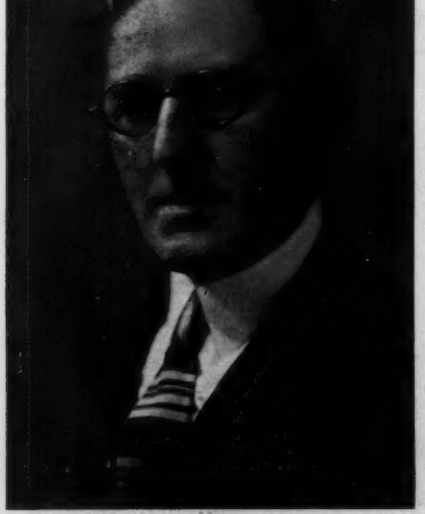
THE scientific development of the natural gasoline industry finds its outlet through the annual meetings of the Natural Gasoline Association of America.

In order to present this in compact form, the papers of the seventh annual convention, held in Tulsa, May 22, 23 and 24, are compiled on succeeding pages. Captions at the top of the pages are accordingly used to give proper credit to the association.

Those not privileged to attend the convention can here find the scientific record, exclusive of discussions. For those, who attended the seventh annual convention, the following pages offer a permanent record.

From a study of the literature it is apparent that the quantity and quality of natural gasoline permissible in satisfactory motor fuels is practically unlimited as far as actual engine operation is concerned. As a matter of fact, automobiles have been operated on liquefied petroleum gas. In practice with automobile carburetors universally adjusted for refinery gasolines, the vapor-locking tendency of motor fuels containing unusually large proportions of natural gasoline becomes the limiting factor in defining the quantity and quality of the natural gasoline that can be used.

GEORGE L. RATCLIFFE
Third Vice-President



A. V. BOURQUE
Secretary-Treasurer

Vapor-locking is due to the tendency of the fuel to boil in the presence of its own vapor. A small amount of vaporization is harmful. To date, the most precise way of evaluating vapor-locking tendencies has been by means of vapor pressure determinations.

In considering the volatility of natural gasoline one is confronted with a wide variety of products. For natural gasolines of every commercial gravity there are distillation losses varying over the entire range of commercial specifications. Vapor pressures are also extremely variable for a given gravity or a given distillation loss. The subject seems hopelessly confused. Many of these extreme variations disappear when the matter is examined from a viewpoint of what might be termed the base material, namely, the butane-free gasoline which the industry is capable of producing. Although our finished products seem as different as the poles most of these differences are brought about by the quantity and composition of the butanes and lighter included in them. As a general thing, the butane-free base of the industry is a relatively constant material. With a raw material as variable in its composition as is natural gas it is not to be expected that the butane-free base would always be the same. But there is a far greater degree of uniformity between the butane-free bases than between the finished products. In the first place, the distillation recovery is almost 100 per cent. In the second place, the variations in gravity, vapor pressure and Engler distillation characteristics are largely a function of the percentage of pentanes included in our product. It might be added that our pentane-free base is a still more constant material than the butane-free base.

The Base Material

Besides the relative constancy in the properties of butane-free natural gasoline there are economic reasons why this product should be considered the base material of our industry. As a general thing, butane-free gasoline is the most volatile natural gasoline which can be used as a direct motor fuel. It consequently follows that the least return the natural gasoline industry can expect for its product is U. S. motor prices for the butane-free gasoline it can produce. This basis affords us a rational viewpoint as to the rock bottom for the price structure of the natural gasoline markets.

Figure 1 shows the characteristics of butane-free natural gasoline prepared synthetically by adding a typical pentanes fraction to a 68 degree A. P. I. pentane-free base. For purposes of comparison the distillation characteristics of the base are shown and also of a grade C gasoline having a high

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pentane base. The 78.5 degree A. P. I. butane-free product has been found to be fairly close to the average butane-free gasoline. Any considerable divergence from this average is the exception rather than the rule.

A study of the Engler distillation characteristics of these butane-free gasolines is clearly indicative of the facts that these products have great possibilities as fuels for airplane motors and that when used directly as automobile fuels are excellent cold weather fuels. By blending proportions of refinery gasolines, far smaller than is customary with our usual products, butane-free gasoline can be provided with a 90 per cent. point in the Engler distillation curve to make a good motor fuel for all climatic conditions.

A study of the vapor pressures of these butane-free gasolines has shown that the vapor pressure of the pentanes fraction alone is about 17 pounds per square inch absolute at 100 degrees F. while that of the pentane-free base is about 4 pounds per square inch absolute at 100 degrees F. The vapor pressure of butane-free natural gasoline can be expected to range from 8 to 14 pounds per square inch absolute at 100 degrees F. with an average value of about 11 pounds. A study of motor fuels actually being marketed shows vapor pressures ranging from 5.8 to 18.6 pounds per square inch absolute at 100 degrees F. with an average value of about 10 pounds per square inch. It is evident from these data that butane-free gasoline is superior from a vapor locking viewpoint to the more volatile motor fuels used by the public.

This comparison of the vapor pressures of butane-free gasoline and ordinary motor fuels affords some indication of the relative handling losses. There is no reason to believe the handling losses of butane-free natural gasoline should be measurably greater than those encountered in the handling of ordinary motor fuels.

It is interesting to compare the properties of butane-free gasoline in the light of our standard specifications. Except in the rare instances when the butane-free base has an unusually high pentane content butane-free natural gasoline would be classed as Grade A gasoline. There is, however, a vast difference between this butane-free gasoline and the type of natural gasoline originally labeled Grade A.

We are all aware that the temperature of the receiving cylinder bath in our standard distillation test has been changed from 60 degrees F. to 32 degrees F. This change has had a very significant effect on the apparent properties of our products. Some of our Grade C gasolines of today, if subjected to the 60 degree F. temperature test would not have over 60 per cent distillation recovery. However, if the 60 degrees F. test is applied to butane-free gasoline it has the same recovery as in the 32 degrees F. test.

The butane-free base of the industry has changed in the last few years, primarily because of the increased efficiency of extraction. Improvements in distillation processes and the better balancing of the elements of gasoline plants have been chiefly responsible for this change. Modern gasoline plants are capable of removing practically all of the pentanes and heavier from natural gas. Many compression plants and the pioneer low pressure oil absorption plants were frequently very inefficient in this respect. But today the skill of the industry has made it economically possible for plants to be designed and operated efficiently. The result of this increasing application of sound engineering practice has been to gradually bring the Engler characteristics of the average butane-free base from the region of the least volatile base shown in Figure 1 to the average value shown.

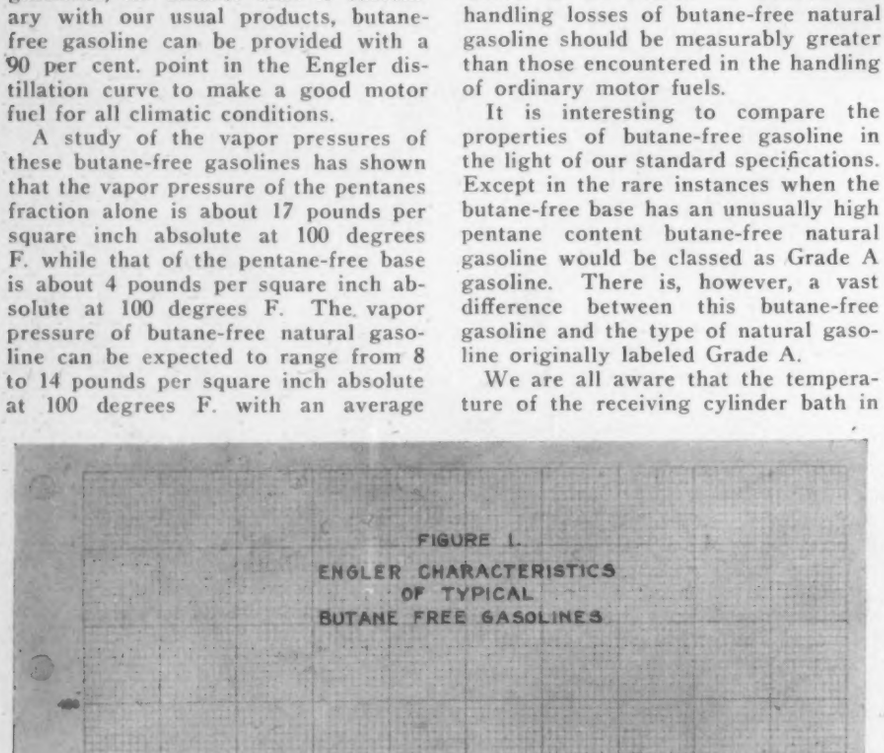

FIGURE 1.
ENGLER CHARACTERISTICS OF TYPICAL BUTANE FREE GASOLINES

Butane-free gasoline has proven to be an excellent aviation fuel. Tests indicate it has a benzol rating between 40 and 50. It weighs 5.32 to 5.76 pounds per gallon as compared with 6.0 pounds per gallon for the customary grades of aviation gasoline. In tests of long duration it has proven to yield at least the same flying hours per gallon and has shown noticeably improved operating characteristics as compared with customary grades.

Figure 2 shows a comparison of the Engler characteristics of aviation gasolines as prescribed by the United States Federal Specifications Board with those of butane-free gasolines. In addition, the Engler characteristics of the gasolines used by Art Boebel in winning the Dole prize are shown in Figure 2. It is to be noted that Federal specifications for aviation gasoline are prescribed in terms of minimum volatility. The difference between the domestic grade and the fighting grade is a considerable increase in volatility.

In marketing aviation gasolines derived from natural gasoline we are confronted with the problem of the maximum volatility rather than the minimum. There is a maximum limit as well as a minimum. The chief problem in this field has been to convince consumers that our product is not too volatile. It behooves all of us who have entered this field, or plan to enter it, to study diligently this prob-

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lem of maximum volatility. One false step by any unit of the industry will create a prejudice against our product we will be a long time in overcoming, regardless of the merits of natural gasoline. The trend of custom is a sufficient obstacle without making an inferior product add to our difficulties.

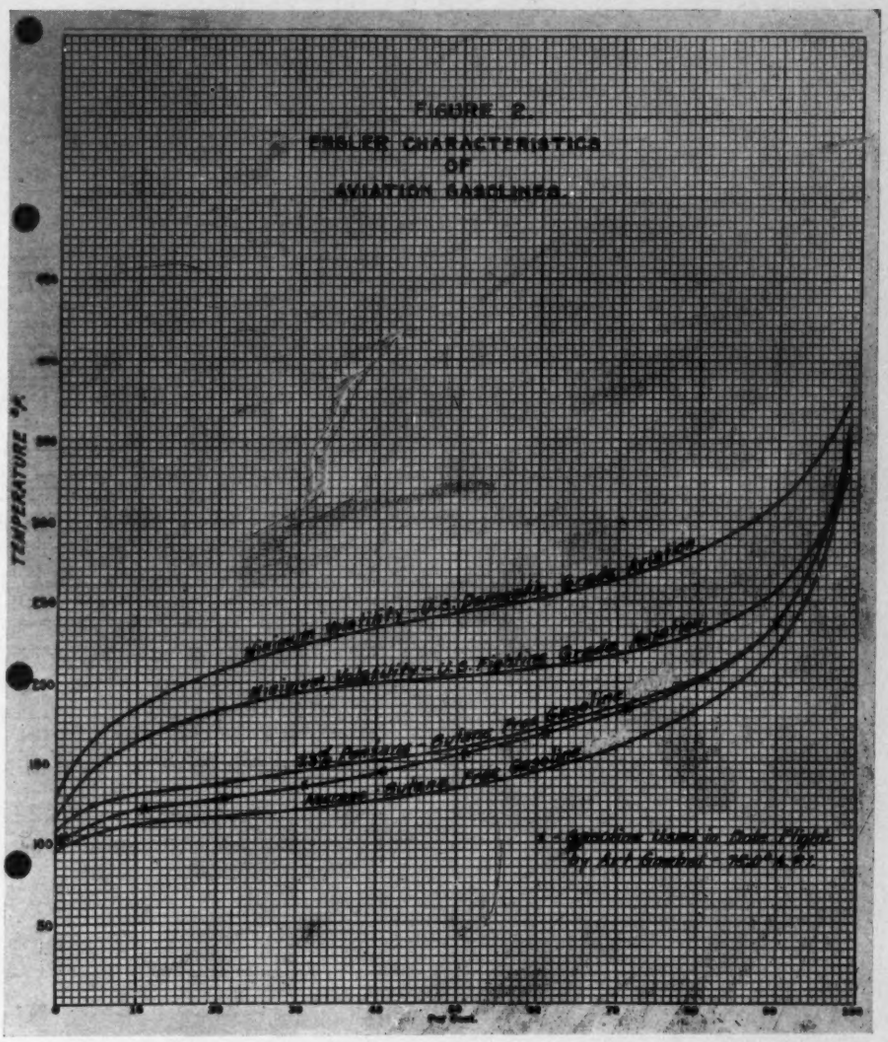
With the preceding review of the properties and possibilities of butane-free natural gasoline in mind it is evident that whatever "wildness" natural gasoline possesses is due primarily to the butane included in it. This is due to the fact that natural gasoline contains very small percentages of hydrocarbons more volatile than butanes. Propane is responsible in a lesser degree and the effects of ethane and methane can be said to be negligible. In this connection all the arguments, besides the question of cost, against the use of larger proportions of natural gasoline in motor fuel have been directed against the excessive "wildness" of natural gasoline.

The butane fraction of natural gasoline normally has a vapor pressure of 56 pounds per square inch absolute at 100 degrees F., an average boiling point of about 20 degrees F. and a gravity of about 112 degrees A. P. I. There are indications that the presence of butane in natural gasoline materially raises the anti-knock value of the gasoline.

Better Prices

Butane is available in the average natural gas in quantities equal to the amount of pentanes and heavier. Frequently there are more butanes present in natural gas than pentanes and heavier. The problem of how much butanes to incorporate in the finished natural gasoline merely depends on the efficiency of extracting it from the natural gas and the efficiency of the fractionation to which the extracted vapors are subjected. In its larger aspects this problem resolves itself into an economic one. A study of the markets for natural gasoline makes it seem highly probable that if the average butane content of natural gasoline were reduced, the increased prices would more than offset the loss in production.

Figure 3 shows the effect on boiling points as reflected by the Engler distillation characteristics when butanes and lighter are added to an average butane-free base. The Standard Engler distillation cannot accurately determine boiling points of mixtures containing considerable quantities of components boiling below room temperatures. The purpose of Figure 4 is to show that for a given butane-free base there is a fairly definite trend for the portions of the Engler curves above 100 degrees F. as the content of butanes is varied. It is, of course, possible to judge the trend of boiling



points below 100 degrees F. by extending the distillation curves below 100 degrees F. in a direction roughly parallel to the corresponding portion of the curve for the butane-free base. But this method can be only an approximation. Until a considerable mass of information has been obtained concerning the relationship of the Engler characteristics of natural gasoline to actual automotive requirements the Engler distillation curve, and particularly the Engler distillation loss, will fail as a precise means of determining the true volatility of natural gasoline.

A vapor pressure determination will give as much, if not more, information concerning the limitations of our products than the present Engler distillation tests. There may be some who will take exception to this statement. However, it is based on Dr. Brown's findings that as far as actually operating the automobile engine is concerned, very large proportions of "wild" natural gasoline can be used. These findings have been very ably demonstrated in terms of the Engler characteristics of the motor fuels. The limiting factor as to the maximum proportions of natural gasoline which can be used in motor fuel is bound to be the vapor-locking tendency of the blend produced. Since that portion of the Engler distillation curve which could be a guide to vapor-locking tendencies is unreliable due to experimental conditions another yardstick must be found. There can be no doubt that vapor-locking tendencies are a function of the vapor pressures of the fuels.

Effects of Butane

Figure 4 shows the effect on vapor pressures of adding butane to various butane-free bases. The middle curve represents the probable average butane-free base; the other two curves, the extreme variations in butane-free bases. The upper curve would be encountered most frequently at plants which treat residue gas, the lower curve at plants which lose pentane. There are, of course, some instances in which the natural gas provides the extremes in butane-free bases.

An examination of Figure 4 shows that the addition of each per cent of butane increases the vapor pressure

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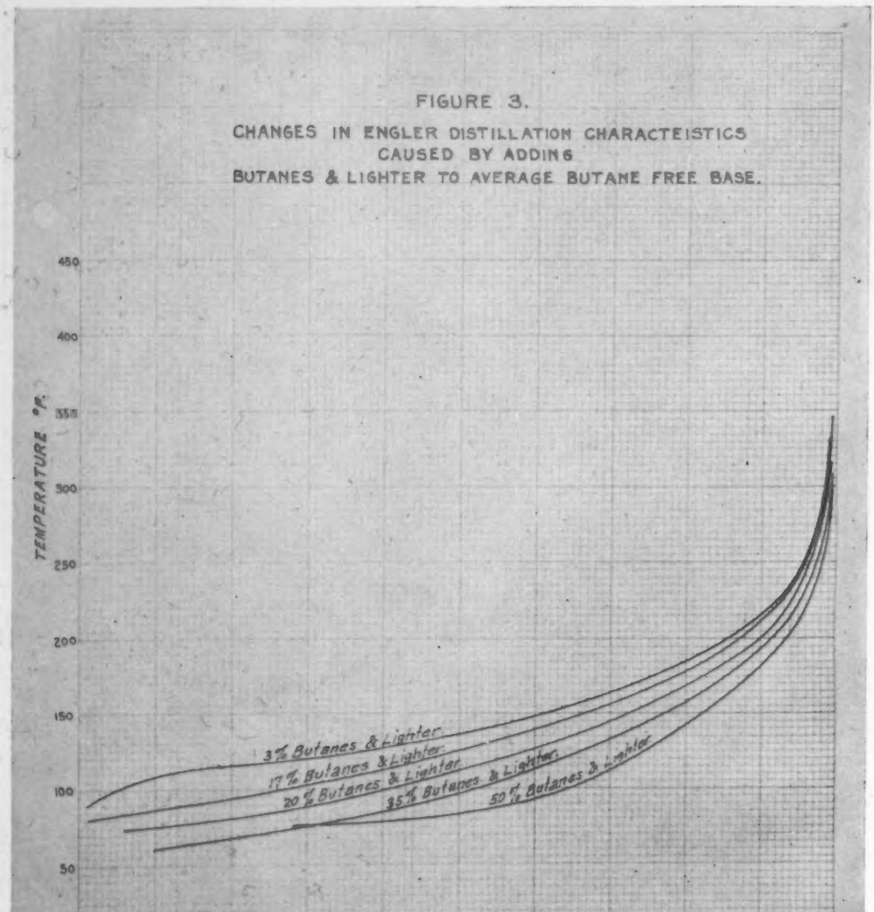

at 100 degrees F. by approximately one-half pound per square inch. This increase in vapor pressure is the factor which limits the markets for natural gasoline.

In order to illustrate this fact more forcibly Figure 5 has been prepared. Figure 5 shows the decreasing proportions of natural gasoline that can be mixed in motor fuels as butanes are added to the average butane-free natural gasoline. The basic assumptions on which Figure 5 is based are that a blending material having a vapor pressure of eight pounds per square inch absolute at 100 degrees F is available to the natural gasoline industry and that the average finished motor fuel has a vapor pressure of 11 pounds. That these assumptions closely represent average conditions is strikingly demonstrated in Figure 5, in which an 11 per cent blend corresponds with an average butane content of 28 per cent. These factors closely coincide with present conditions in the industry.

The steepness of the curve in Figure 5 in the neighborhood of 10 per cent butane is clearly indicative of the greatly increased utility of natural gasoline as its content of butanes and lighter is decreased. In dropping from 28 per cent to 10 per cent butane there would be a loss of 20 per cent in production, but instead of 11 per cent natural gasoline there would be required 27 per cent, in the average finished motor fuel. This represents more than 100 per cent increase in the demand for natural gasoline.

It is certainly evident that the increased efficiency of the natural gasoline industry has been a boomerang. Production has climbed to gratifying heights and prices have sunk to distressing levels.

An infinite number of curves such as the one shown in Figure 5 might be prepared depending on the basic assumptions used. It might be possible that the vapor pressure of the average motor fuel could be raised to 12 pounds or more. It is certain that cracking processes and vapor recovery systems at refineries will raise the average vapor pressure of the refinery gasoline fraction above eight pounds. But regardless of the assumptions used the resultant curve will be similar to the curve shown in Figure 5 and it will describe the economic limitations of the natural gasoline industry as nothing else can.

Thus far, the effect of adding butanes to our butane-free base has been considered. Natural gasolines can also contain propane, ethane and methane since these exceedingly volatile gases are present in large proportions in natural gas. Ethane and methane can logically be ignored, because these constituents are effectively eliminated from the finished product except in the most inefficient plants. This leaves propane as the only material besides the butanes which measurably adds to the vapor pressure of natural gasoline.

Propane boils at —47 degrees F., has a vapor pressure of 186 pounds per square inch at 100 degrees F. and a gravity of 147 degrees A. P. I. It is reasonable to believe that propane has more pronounced anti-knock tendencies than the butanes.

The effect of propane on the quality and utility of natural gasoline has been grossly exaggerated. According to popular repute, the very existence of the natural gasoline industry is at the mercy of this prodigal son of the hydrocarbon family. Such is not the case. Propane is not necessarily a contaminant of natural gasoline. Too much propane is a contaminant just as too much ethane, methane or butanes is a contaminant.

There are many instances in which the presence of propane in the finished product is a step toward efficiency. The following are several such cases:

1. Overloaded plants are frequently built in flush fields. Such plants cannot extract enough butanes to make their finished product as volatile as their sales specifications permit. The inclusion of some propane in the finished product serves to increase production and make the product as volatile as sales specifications allow.

2. Some natural gases are deficient in butanes so that propane must be added to the finished product to maintain production at as high a level as is consistent with sales specifications.

3. Inefficient extraction systems are by no means uncommon. In such instances a deficiency in the butanes extracted could be compensated by adding propane although probably the most profitable procedure would be to improve the efficiency of extraction so there would be no shortage of butanes within sales specifications.

4. Natural gasoline is sometimes transported in crude oil lines for the express purpose of reducing the viscosity of the crude oil. In such instances it is found profitable to include practically all of the propane extracted in the natural gasoline.

5. Where large quantities of blending material are available at a gasoline plant it is frequently profitable to include propane in the natural gasoline blended.

Using Dr. Brown's definition of volatility for the moment, which is briefly

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"ability to vaporize under specified equilibrium conditions," the effect of propane in natural gasoline can be only very slight as compared with the effect of butanes. The physical properties of propane preclude large percentages in finished natural gasoline, while the physical properties of the butanes permit large proportions in the finished product. With natural gasolines containing 40 per cent butanes and lighter, one of which is free of propane and the other contains 4 per cent of propane, there can be little to choose between their abilities "to vaporize under specified equilibrium conditions." In judging such gasolines on the basis of a Sligh air equilibrium distillation the first 10 or 20 per cent evaporated would probably be distinguishable but the remaining large per cent evaporated would closely coincide. In motor fuel blends containing 10 per cent of such natural gasolines the effect of the propane would be scarcely distinguishable in Sligh air equilibrium distillations.

These considerations lead to the conclusion that the limiting factor in regard to propane in natural gasoline is its effect on the vapor pressure of the finished product. In other words, what are the vapor-locking tendencies of motor fuels containing natural gasoline which has propane in it?

In the absence of direct tests the only way to arrive at an estimate of the vapor-locking tendency of propane in natural gasoline is to calculate the vapor pressures of natural gasolines containing definite proportions. Such calculations have been presented elsewhere.* These data are reproduced here graphically in Figure 6. One per cent propane raises the vapor pressure of natural gasoline 1.9 pounds per square inch at 100 degrees F. as compared with 0.5 pounds per square inch for one per cent butanes.

Vapor-locking is probably a function of vapor-pressure. Vapor-locking is caused by fuel boiling before reaching the carburetor jets. A small amount of boiling is harmful. The vapor pressure of a liquid is a measure of its tendency to boil. By definition the two things are practically the same. Consequently propane should add to vapor-locking tendencies in proportion to its vapor pressure. For purposes of showing the comparative vapor pressure effects of butane, iso-butane and propane Table 1 is presented.

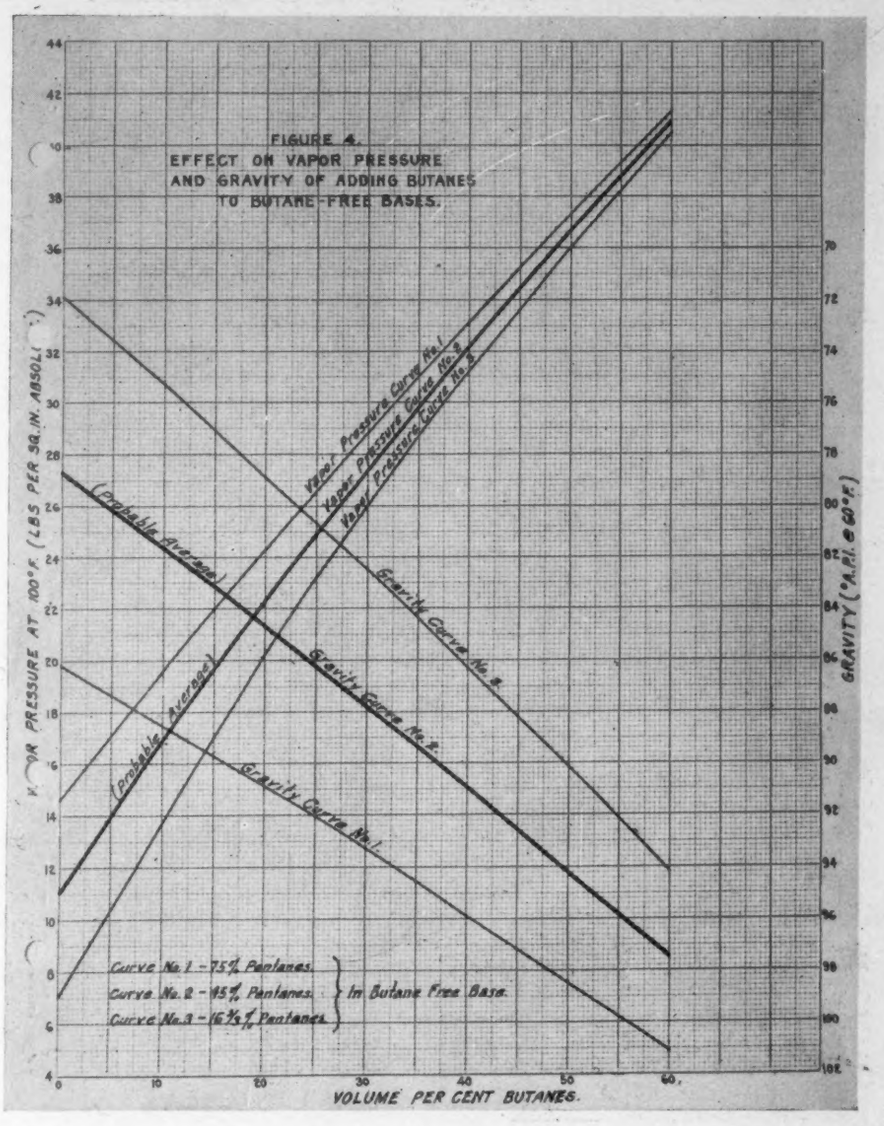
FIGURE 4.
EFFECT ON VAPOR PRESSURE
AND GRAVITY OF ADDING BUTANES
TO BUTANE-FREE BASES.
VAPOR PRESSURE AT 100°F. (LBS PER SQ. IN. ABSOL.)
GRAVITY (°A.P.I. @ 60°F.)
VOLUME PER CENT BUTANES.
Vapor Pressure Curve No. 1
Vapor Pressure Curve No. 2
Vapor Pressure Curve No. 3
(Probable Average)
Gravity Curve No. 3
Gravity Curve No. 2
(Probable Average)
Gravity Curve No. 1
Curve No. 1 - 75% Pentanes.
Curve No. 2 - 45% Pentanes. } In Butane Free Base.
Curve No. 3 - 16 2/3% Pentanes.

With the relatively small proportions of propane and the relatively large proportions of butane normally present in natural gasoline it is evident from Table 1 that propane in natural gasoline is not a serious contaminant from a motor fuel viewpoint. From a viewpoint of maximum utilization of natural gasoline in refinery products, it is advisable to maintain the percentages of both propane and butane at reasonably low levels.

Very little has been mentioned in this paper regarding gravity and distillation loss. These are the specifications with which our various grades are commercially defined at present. Any estimate of the true volatility of natural gasoline must now be reached through a consideration of both these properties.

The gravity of natural gasoline is a definite physical property which can be accurately determined. It has a limited significance as far as overall volatility is concerned, and absolutely no significance in regard to vapor pressure. With a steadily declining emphasis on the gravity of finished motor fuels it can be expected that the gravity of natural gasoline will become less important.

The effect on the gravity of adding butanes to various butane-free bases is shown in Figure 4. The effect of substituting one per cent. of propane for one per cent. of butane is to raise the gravity approximately 0.3 degrees A. P. I., or to lower the specific gravity 0.00072. The gravity curves in Figure 4 are for the same butane-free bases used in the vapor pressure curves.

Figure 4 shows the following limits

TABLE 1
Vapor Pressure of Propane, Iso-Butane and Normal Butane

		Temp. (°F.) (Pounds Per Square Inch Absolute)			
A	Butane	21.55	52.5	107.5	195.8
	Iso-Butane	32.0	74.0	144.2	257.3
	Propane	91.00	186.4	343.0	579.0
B	Iso-Butane	1.499	1.410	1.342	1.308
	Propane	4.225	3.550	3.190	2.944

A—Vapor Pressures.
B—Ratios of vapor pressures to vapor pressures of normal butane.

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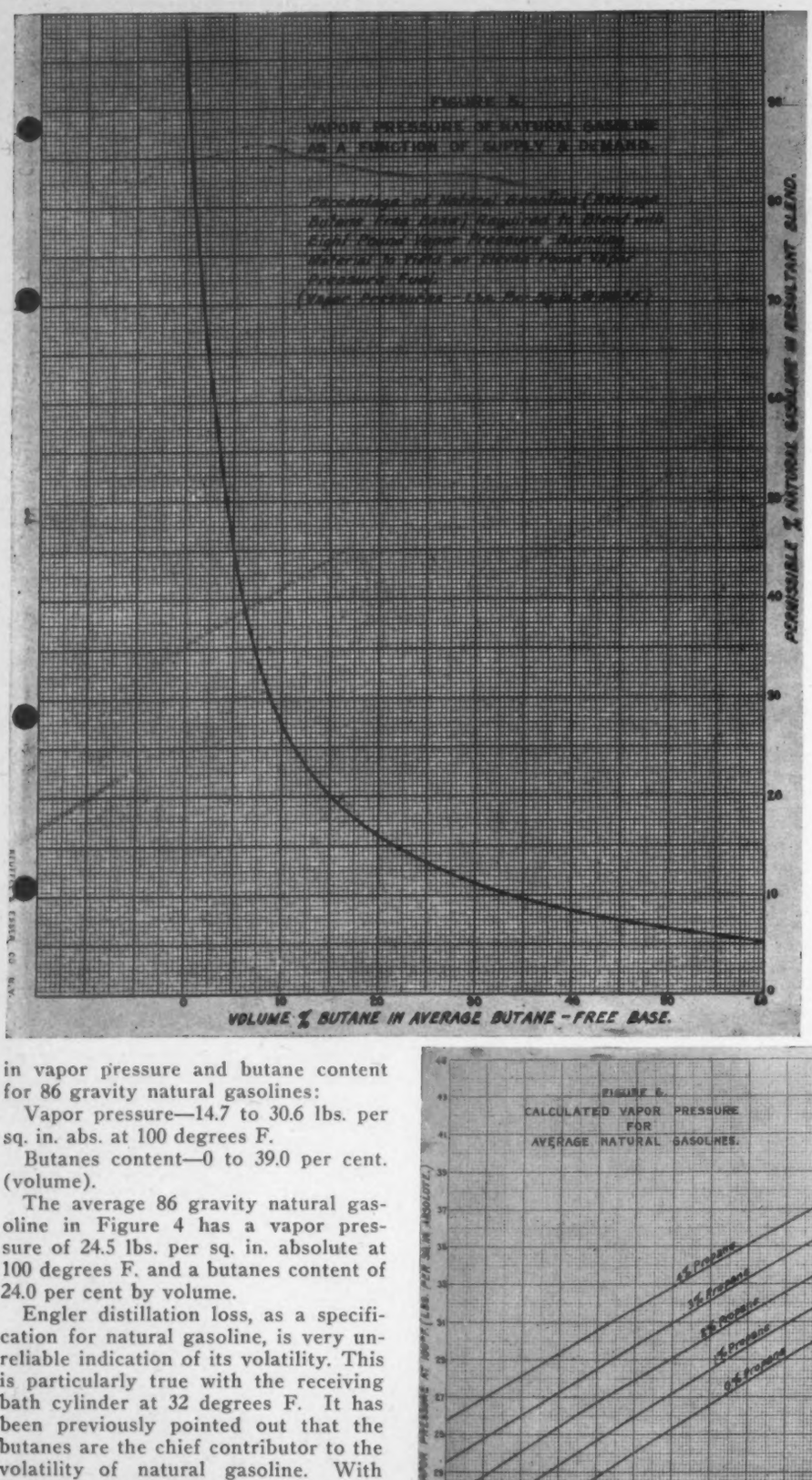


in vapor pressure and butane content for 86 gravity natural gasolines:

Vapor pressure—14.7 to 30.6 lbs. per sq. in. abs. at 100 degrees F.

Butanes content—0 to 39.0 per cent. (volume).

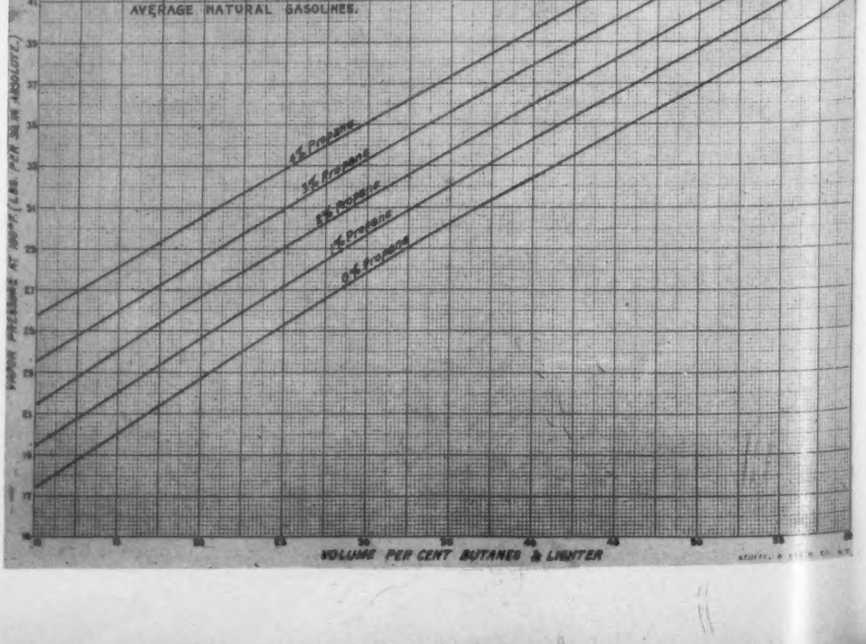
The average 86 gravity natural gasoline in Figure 4 has a vapor pressure of 24.5 lbs. per sq. in. absolute at 100 degrees F. and a butanes content of 24.0 per cent by volume.

Engler distillation loss, as a specification for natural gasoline, is very unreliable indication of its volatility. This is particularly true with the receiving bath cylinder at 32 degrees F. It has been previously pointed out that the butanes are the chief contributor to the volatility of natural gasoline. With the whole condensing and receiving system in our distillation test maintained near the boiling point of the butanes fraction it is apparent that a very large proportion of the butanes will be recovered. The change from 60 degrees F. to 32 degrees F. for the receiving cylinder bath temperature has been responsible for increasing the volatility of natural gasoline more than any other factor. With the receiving cylinder bath at 60 degrees F. Engler distillation loss is a much more reliable guide to the volatility of natural gasoline.

At the best, however, distillation loss can not be a definite indication of the volatility of natural gasoline. Consider natural gasoline containing 40 per cent. of butanes and lighter with the same proportions of propane, iso-butane and normal butane, within practical limits. As the pentanes contents of these gasolines are increased and the hexanes and heavier contents are decreased, the vapor pressures will increase, but the distillation losses will decrease. This is due to the fact that as the pentanes contents are increased the partial pressure of pentane in the mixtures are increased, thus causing them to vaporize earlier in the distillation. The early presence of pentanes in the overhead vapors raises their dew points and brings about greater Engler distillation recoveries. Thus as the vapor pressure increases the distillation loss decreases.

The natural gasoline industry and the refiners have acquired a great deal of empirical knowledge of the volatility of natural gasoline based on gravity and Engler distillation loss as specifications. It has been aptly expressed that we measure the shadows to determine the substance itself. Gravity and Engler distillation losses are truly shadows of the essential property of natural gasoline, which is volatility.

Rational specifications for natural gasoline would be the Engler characteristics above 100 degrees F. with the distillation loss plotted on the front and plus vapor pressure. With such



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information at hand, the user of natural gasoline could judge definitely as to the utility of the product. If the natural gasoline is to be blended, the Engler distillation curve of the resultant blend can be predicted and the vapor-locking tendency can be calculated. Under such specifications, gravity would take care of itself, within working limits.

In conclusion, regardless of periods of overproduction and underproduction of natural gasoline the more manufacturers and users know about natural gasoline the greater will be the markets for their products. I am firmly convinced that our present specifications are misleading and have much to do with our failure to expand markets. There is too much tendency to buy gallons of natural gasoline when specified and definite volatility should be purchased. When we can definitely measure the volatility of natural gasoline we will be in a position to market our products ourselves, if need be.

The signs point definitely to a long-continued overproduction of natural gasoline. Circumstances will force us to shift for ourselves to a much greater extent than ever before. New economic conditions are confronting the industry. Let us not be satisfied with the shadows in order to be well prepared for the future.

After hearing this paper on the volatility of natural gasoline, you are all probably convinced that I am ultra-pessimistic concerning the future of our industry. I have probably conveyed that impression in attempting to present some fundamental facts pertaining to the utility of our product. I wish to correct that impression. I am more optimistic than ever regarding the future of our industry. We have gone far enough to know that there are plenty of markets available for our products. Natural gasoline occupies a potentially unique position in the fuel class and a most important position in the hydrocarbon family. Natural gasoline is rightfully a raw material which contains those constituents essential to high quality motor fuels and superior industrial gases. Our problem is to first know our own products and see that they are intelligently used. The future will then take care of itself.

The Importance of Analysis in the Natural Gasoline Industry*

By W. W. ROBINSON, JR.
Chief Chemist, California Natural Gasoline Company

THE NATURAL gasoline industry has been in existence 25 years, but it has only been recently that the problems of the industry have been attacked to any appreciable extent from a scientific standpoint. In the past two years scientific research has given information as to the value of natural gasoline as a component of motor fuel. It is now time that scientific research be directed toward the solution of what is a very important problem affecting the economic life of the industry. This problem is the analysis of natural gas and gasoline to determine their hydrocarbon constituents. Absolute data, applicable to equipment design, and manufacturing operations, with the rapidly growing importance of rectified gasoline, must, of necessity, be available to all in the near future to replace the questionable empirical data and unstable assumptions so generally accepted. On all sides are heard discussions and opinions which are so conflicting that it is evident that a great deal is not yet known as to the exact composition of natural gas or gasoline, nor the relation which a virgin gas composition bears to absorbability in oil, or what specific properties may be expected in the gasoline derived from it.

Please note, in the discussion to follow, that wherever the terms gas or gasoline appear, they shall be understood to mean natural gas and natural gasoline. Where occasion arises to mention gasoline as made by the crude oil refiner, it shall be called motor fuel.

Gas as ordinarily treated in a gasoline plant contains relatively large percentages of the hydrocarbons methane and ethane, and relatively small percentages of the hydrocarbons propane, butane, pentane, hexane and higher. Most of the published analyses are based on the assumption that the hydrocarbons contained in the gas are of the paraffine family, and while it has been proven more or less definitely that this condition does not, by any means, hold true for all gases, for purposes of discussion it will be satisfactory to assume that the hydrocarbons are all normal paraffine hydrocarbons, or, if they are not, that they will fall into the same boiling point groups as the normal paraffine hydrocarbons.

The Questionable

Having made this assumption, we can proceed to sub-divide the hydrocarbons contained in the gas which is treated in gasoline plants into three distinct groups. In Group 1 can be placed all the methane, ethane and propane or equivalent fractions contained in the gas. These hydrocarbons are fixed gases at normal temperatures and enough data is available for us to conclude definitely that these hydrocarbons are "undesirables" and should not in any case be included in gasoline. In Group 3 can be placed pentane, hexane, heptane and all of the other higher boiling point hydrocarbons. All available data proves conclusively that these hydrocarbons are "desirables" and should unquestionably be included in gasoline

In Group 2 we can put butane (and all other hydrocarbons having the same boiling point and similar properties). This group is not all desirable in gasoline. A certain percentage of the total amount of it contained in the gas is desirable and should be included with the pentane and higher in the finished gasoline. The balance, at least for the present, will have to be rejected, along with the hydrocarbons in Group 1, as undesirable. The exact percentage of Group 2 which can be retained in gasoline depends upon conditions. It depends upon the relative quantity of Group 3, or desirable hydrocarbons, which is available in the gas, and upon the specifications by which the finished gasoline product is controlled.

The status of Group 2 might be termed "questionable," in that above certain limits of concentration, it can cause trouble closely akin to that of "wildness." Therefore, the exact determination of the percentage of Group 2 which may be included in the finished product is of great importance, and makes it essential that each manufacturer know, with precision, the percentage of Group 2 and Group 3

*Presented before the annual convention of the Natural Gasoline Association of America, Tulsa, Oklahoma, May 22, 23 and 24, 1928.

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in both gas and gasoline. The necessity of knowing Group 1 being self-evident.

It is of great commercial importance to improve over the existing commonly used methods of gasoline and gas analysis, as represented by vapor pressure, Engler distillation, and the atmospheric and pressure charcoal tests. An exact and more fundamental method is needed.

Why should a quick, accurate method of determining the hydrocarbon constituents present in gas and gasoline be developed? What can be done with the method after it has been developed, and will the results be justified by the cost? There are many reasons why such a method is desirable, but in a paper of this length it is impossible to more than outline the principal reasons why such a method would be desirable or important. We have only to look away from this industry a moment to see that as a result of competitive conditions, questionable empirical data has been replaced today in practically all other industries by that which is scientific and accurate.

The first place where it would be desirable to have an accurate means of determining the composition of gas would be when new fields were opened up and it became advisable to consider the treatment of the gas in a gasoline plant. Analysis would reveal the presence of undesirable compounds and would enable the prediction of the yield of specification gasoline which could be produced from that particular gas. The information obtained from the analysis would facilitate the economic design of a plant to recover the gasoline from the gas.

To meet competitive conditions today it is necessar yto build a plant to produce the desired results at the lowest possible cost. Analysis of the gas would enable the plant to be designed on this basis instead of the customary manner, where the design is more or less a matter of good judgment on the part of the designer.

Knowledge of the composition of the gas would facilitate the design of absorbers and give more exact information on the number of plates necessary in the absorber and the quantity of absorber oil circulation needed to efficiently extract the desirable constituents from the gas. (The recent article by Dr. W. K. Lewis on absorber design clearly indicates the great advantage of knowing the chemical composition of the gas to be treated.)

Analysis would make possible the correct design of stills and columns for controlling the end point of the gasoline produced.

Analysis would facilitate the design of rectifying columns for separating the undesirable constituents of the gasoline extracted from the desirable constituents, and would enable the definite design of compressor installations for plants utilizing the compression process of extraction.

For plant operation, analysis would be, perhaps, even more important than for plant design. The efficient gasoline plant should extract all of the Group 3 hydrocarbons (pentane and higher) contained in the gas which is economically possible. In order to accomplish this end, it is necessary to extract more of the Group 2 hydrocarbons—(butanes)—than can be utilized in the finished product. Likewise, it is necessary to extract a considerable amount of the Group 1 hydrocarbons — (propane, etc.) — which are not desired at all in the finished product.

An Aid in Operation

How do we determine today that this end has been accomplished We do it by means of a number of different empirical tests, perhaps the most general in use being one of the many forms of charcoal test. Suppose a plant dry gas is tested by means of the atmospheric charcoal test and found to contain .06 or .08 gallons of "gasoline" per 1,000 cubic feet treated. What does this .06 or .08 mean? As the condensate from a charcoal test, it means nothing but a certain amount of liquid whose volume enters into the test calculation in such a manner as to yield the numbers .06 and .08. What is this liquid, is it butane, or pentane, or hexane? Does this give any positive information which is so desirable? It is to be feared that even the most optimistic will agree that it does not.

Fundamental analysis has shown conclusively that the charcoal test, no matter how it is made, does not furnish definite information as to the amount of pentane and higher hydrocarbons left in dry gas. Dry gases giving the same gasoline content by the charcoal test will show varying percentages of pentane and higher hydrocarbons by fundamental analysis. In a great many instances it would be possible to remove from five to ten per cent. more of this fraction from the gas under economic conditions, made possible by exact chemical control.

Immediately the question arises as to whether or not it is desirable to extract more gasoline from gas when it is not known what to do with the gasoline extracted under present conditions. This question can be answered by stating that the aim should not be to extract more gasoline from the gas, but to extract more of the desirable constituents of gasoline from the gas, and, later on in the process, by rectifying the gasoline produced, eliminate the undesirables and have a finished product which is more desirable, and therefore more easily marketed. The only way to tell whether or not the desirable constituents have been completely removed is by analyzing the dry gas leaving the absorbers. In other words, absorbers and all other equipment, should not only be designed, but should be operated according to fundamental analysis—not estimation. Would it not be advantageous to develop an analytical method, which would make exact control possible?

Equipment efficiency is usually expressed as an increase in production of gasoline — what kind of gasoline, whether wild or stable, not being stated. Who can estimate the millions of dollars of plant equipment in the form of absorption towers, stills, etc., which have been thrown into the junk pile for no other reason than a haphazard substitution of new equipment for old in an endeavor to improve extraction with no scientific means used to determine beforehand whether the result would justify the expenditure?

The governing factor which controls the size, and consequently the cost, of the majority of the equipment used in extracting gasoline from gas is the absorber oil circulation. The quantity of oil to be circulated is one of the first things that must be decided upon, and this factor controls the size of pumps, the size of lines, heat exchange apparatus, stills, cooling apparatus, and so forth. If the plant is properly designed, the oil circulation will be so proportioned that it will extract from the gas the maximum economical percentage, as stated previously, of the Group 3, or pentane and higher hydrocarbons.

The design, however, is based on the assumption that the absorber oil delivered to the absorbers will be completely stripped of the lighter gasoline hydrocarbons in the still. If the absorber oil is not completely stripped of these hydrocarbons the efficiency of absorption is decreased, and in a plant operating at full capacity the efficiency of the entire plant is lowered. Consequently it becomes an important matter in operating a gasoline plant to operate the still in such a manner that the absorber oil returning to the absorbers will be completely stripped. How is it possible to determine when this has been accomplished?

Many methods are being used to make this determination. Chief among these are, perhaps, the vapor pressure tests made on the stripped absorber oil, and Engler and Hample distillations of the oil to determine the percentage of lighter constituents contained therein. It is true that these

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methods give a rough approximation of the condition of the oil, but the information obtained by them is much too indefinite to be used as an important method of control in plant operation.

Another point is the use of vent tanks for venting enriched oil before distillation. Is it not important to know the composition of these vapors and the loss of Group 2 and Group 3 constituents? A method of analysis would unquestionably result in a positive control of these factors.

In the operation of a gasoline plant today it is necessary, if it is desired to produce a finished product which will meet with a ready market, to rectify the plant make in order to make a sharp separation between the hydrocarbons which are desirable and those which are undesirable in the finished product. The manufacture of rectified gasoline, or gasoline which contains the minimum percentage of the Group 1, or undesirable, hydrocarbons, and a proper concentration of Group 2, is becoming more and more necessary every day. In fact, the future stability of the industry depends to a great extent upon the production of a product of this nature which can be utilized by refiners in the manufacture of finished motor fuel.

The rectification of the plant make is accomplished in various ways by the use of rectifying or fractionating columns. There is no way to tell when the column is operating efficiently without recourse to analysis. The analysis of the gasoline produced by the use of the column is not sufficient inasmuch as it is necessary to know that none of the desirable hydrocarbons are being rejected from the top of the column along with the undesirables. Tests other than analysis do not give any information of value in this connection.

When the plant has finally produced the finished product, how do we know that it meets the requirements of the refiner who is to use it in blending? We may determine the gravity of the gasoline; we may determine its distillation range by means of the Engler distillation, and we may determine its vapor pressure. None of these methods, however, are of any value in determining its composition. According to published data of Dr. Brown[2], the presence of propane, and perhaps certain other undesirables, in gasoline is one of the contributing factors in causing the "gas lock" in carburetors when the gasoline is blended into finished motor fuel. It is impossible to tell by vapor pressure, or the other methods, whether or not the gasoline contains propane, inasmuch as a gasoline containing two per cent of propane may have a vapor pressure of, say 12 pounds at 100 degrees F., and another gasoline may contain no propane and still have a vapor pressure of 12 pounds at 100 degrees F., due to the inclusion of a greater percentage of butane.

Gasoline today finds its major use as a component of motor fuels. The refiner has long been prejudiced against the use of large quantities of gasoline in the motor fuel which he turns out, primarily because of previous experiences with gasolines containing high percentages of undesirables. Manufacturers have determined for the refiner that the presence of these undesirables limit the amount of gasoline which he may use in his finished product. Now that this has been discovered, it is up to all the manufacturers of gasoline to turn out a product which does not contain undesirables. Suppose this is done. It is not enough to be satisfied that the gasoline does not contain undesirables; but the manufacturer must be able to prove definitely to the refiner that they have been eliminated. The point for serious consideration is that if the maximum of what is desirable in gas can be recovered with a minimum of epuipment; a positive check kept on plant operation, and the production of an undesirable-free gasoline of sustained quality which will make possible a cordial trade relation between manufacturer and refiner, is this not a justification of the commercial value of such methods?

History of Analysis

Work has been done by various experimenters toward developing these all-important analytic methods. From available information, meager though it may be, let us venture into this field and see what the possibilities are. Anderson and Erskine[3] in 1924, resolved gasoline quantitatively into its higher components, by a method of fractional distillation, beginning with pentane. The disappointing part about their work is that they did not study the constituents which interest us vitally, namely: propane, iso-butane, or butane.

Hill-Henderson & Ferris[4] made an indirect study by modifying a method of examination suggested by Cross[5] by fractionating two liter samples through a five foot column. Their results are interesting in that the samples of gasoline analysed were from Pennsylvania, Oklahoma and California, and all indicated marked deviation from the paraffine hydrocarbons. However, their results are empirical, although from a fundamental angle, possibly the low boiling fractions of different petroleums are not essentially paraffines as suggested by Dr. Brooks[6] which would serve to stimulate suspicion as to the nature of gas and gasoline.

Dr. Burrell's work on low temperature-pressure analysis of natural gas has been a stimulus to certain investigators to apply the idea to gasoline. Briefly, Burrell's method[7] is basen on the relation between the vapor pressure of the component sought, and the undesired component. From the vapor pressures of the paraffine hydrocarbons, at low temperatures[8], temperatures were chosen where the vapor pressure of the desired component was in evidence, and that of the undesired component as low as possible. According to this method, and the Shephard-Porter modification[9] butane is separated at —90 degrees C. Ryan [10] transferred the gasoline by means of a burette into a graduated tube held at a temperature of —90 degrees C, and by opening a stopcock from this tube to a second tube held at —183 degrees C. with liquid air, the butane was transferred by temperature difference and the percentage computed from the residue in the graduated tube. This method is primarily for determining the butane content of rectified gasoline, so is limited in application without modification, no account being taken of the undesirables.

High Pressure Method

A western concern worked along the same line, but attempted to make the method adaptable to all types of condensates, such as liquids from high pressure accumulators, tray samples from rectifiers, unrectified gasoline, etc. Their work revealed aggravating conditions which were so slippery that work was abandoned. Vapor pressure indications were unstable and analyses were made where butane was expected at —90 degrees C. and the condensate which was obtained consisted of from 10 to 40 per cent of something heavier than butane.

Another method of gasoline analysis is that of high pressure ordinary temperature rectification. The principle of separation being the same as for the large scale high pressure rectification of natural gasoline, with the vapor pressure curves of the different paraffine hydrocarbons[11] used as a control. By this method, the gaseous fraction of unrectified gasoline has been separated as a lump, but re-analysis has not yet given satisfactory results. Most important of all, qualitative proof is lacking.

A third method which holds tempting possibilities is the low temperature rectification, all glass apparatus, with a slender fractionating column, possibly of the Dufton[12] type.

Next, let us take natural gas analysis.

The principle of the Burrell separation has already been mentioned under gasoline analysis, but the earlier form of apparatus is not prominently in use.

The Shephard-Porter modification of the Burrell method was an effort to speed it up for the purpose of commercial analysis and the preparation of pure hydro-carbons. Attempts by a western company to analyze Cali-

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fornia gas by this method have been met with difficulty. Vapor pressure values seem to deviate for the compounds sought in spite of many vaporizations to remove the last traces of the previous fraction, this deviation assuming large proportions for the cuts for ethane, propane, and butane, and from the fact that so many vaporizations are made, it leaves a suspicion—namely: the presence of ethylene, propylene, cyclopropane, and butylene. Another curious phenomena is the generation of crystalline formations in the distillation tubes. Last of all, engineers do not obtain a quantitative balance in their calculations, using analytic figures obtained.

Another method of analysis, concerning which no data is available, is that of attempting to fractionate natural gas by a tube of activated charcoal at low temperatures by means of a thermogradient.

Secrets Again

From what has been mentioned, it is evident that there are many ways of going at the problem. Progress seems to have been made by different concerns in the development of fundamental analytic methods, but it is impossible to determine the status of these efforts due to the unfortunate attitude of secrecy. Most of these have been developed at considerable expense by individual companies, probably each one incorporating some feature considered by its sponsors to solve the problem; therefore they naturally hesitate to make this information available to others who have not shared the burden.

However, recent comparisons of the results of tests made by different individuals and companies invariably shows that existing methods leave something to be desired. Analysis of the same gas by different methods in use by different companies does not give the same results. Inasmuch as only one result can be correct, it follows that some of the methods of analysis now in use are not as accurate as they might be. The reason for these discrepancies may be due to a multiplicity of viewpoints, both technical and commercial, which can only result in confusion and be a means of retarding development, whereas by getting together and attacking the problem of gas and gasoline analysis collectively, the ultimate solution would be hastened and the industry in general benefited thereby.

Suppose manufacturers all develop methods of analysis individually and keep them secret, they would still not be able to convince the refiner that they were turning out a product which he should use. Before they are going to meet with very hearty co-operation in this respect from the refiner, it will be necessary to develop methods of analysis which can be used by all, including the refiner himself for determining the character of the gasoline which is delivered to him. There are comparatively few businesses today in which raw or finished materials purchased entirely on the manufacturer's representations, and there is no reason why we should expect the refiner to accept our statements with reference to natural gasoline, unless he is in a position to verify them and reach his own conclusions. To the refiner, natural gasoline is only an incident in his operations, but to the manufacturer it is a matter of life or death, and it is therefore very important that a method of analysis be developed by means of which all concerned can reach their own conclusions.

Perhaps it will not be necessary to develop a method of analysis which will enable us to identify each hydrocarbon separately. It may be sufficient to develop a test which will enable us to identify the hydrocarbons falling into the different groups enumerated heretofore. The solution of this depends upon all concentrating on the development of methods of analysis co-operatively.

All indications point to the fact that the gasoline manufacturer is, in the future, going to be forced to develop the by-product market. There are countless uses for the components of natural gasoline. Unfortunately, we cannot wait until somebody else finds out what these uses are for us. We will have to develop these markets of our own accord. In order to do so rapidly and thoroughly, it is absolutely requisite that we have accurate knowledge as to the composition of natural gasoline.

Suppose one of the companies now having a method of analysis, has a more accurate method than any of the others, they would have little if any chance of profiting financially by the possession of such a method, from the by-product angle. On the contrary, products turned out by such a company could immediately be duplicated by other companies by the simple expedient of obtaining an Engler distillation of the product. They could then place on the market a product which met the distillation specifications, but which would perhaps be an inferior product, and in this manner possibly bring into ill-repute the product of the first manufacturer.

If we concede that the desirable gasoline for the refiners to use is a gasoline which is propane-free, then all gasoline manufactured should be propane-free, but just so long as there are a number of manufacturers making a gasoline which is not propane-free, there will still be a question in the mind of the refiner with reference to the gasoline which he may be purchasing. The only way to insure gasoline being propane-free is to develop a method of analysis which can be used by manufacturers and refiners alike to check up on the composition of the finished product.

The use of pentane gasoline as aeroplane fuel presents substantial possibilities. Some concerns are already manufacturing a pentane gasoline of superior quality, probably controlling its manufacture by private methods of analysis. However, the same condition exists here, as already mentioned. Some manufacturer may attempt the duplication of the well made product from Engler distillation curves, and may obtain the same curve but with butane and propane present. Consumers having trouble with the inferior product will naturally become prejudiced against pentane gasoline in general and mar the reputation of the conscientious manufacturer.

Supposing we have fifty and one different ways of analyzing gasoline, how will we ever prove to the refiner that it is possible for him to have compounds in his own product that will exercise as deleterious a property as propane, or iso-butane, without any natural gasoline present, if we are at variance concerning our own fundamental concepts. Surely he will be skeptical of our statements if we cannot prove them collectively.

These factors, with hosts of others untold, should jar us into the realization that the time is long overdue when we should know the scientific "why" of our raw-material and product, and collectively agree upon it. We should educate ourselves, through co-operativ research, to know what we must know fundamentally in order to make commercial operations exact, and as profitable as possible.

It is evident that natural gas and gasoline technology must be expanded and improved to meet future conditions, and be able to interpret what commercial research develops. Undoubtedly, many present know that physicists at the Norman Bridge laboratory of the California Institute of Technology are about to attempt a method of gasoline analysis[13] by means of a principle[14] which consists of bombarding the structure of gasoline with minute negative electrical particles called electrons—this phenomena being termed "ionization." The gasoline fractions, which have become positively ionized by means of this electrical bombardment will then be passed through a powerful curved magnetic field in the form of what is termed a "positive ray." This positive ray is then broken up into what is called a "mass spectrum" and each constituent determined with great precision electrically. This work is mentioned to show that scientists are hammering away at the problem too. If the mass

spectrograph should be successful, we will then have a scientific eye which will pierce the outward form of fuels and study their internal structure. Therefore, as an important part of the petroleum industry, let us be prepared technically to realize commercially to the fullest extent what scientific research may give us.

This rough panoramic view of this vitally important problem may serve to stimulate thought on the question. Let us attack it as a body. Natural gas and gasoline should be resolved into their components and studied intensely by each manufacturer in order that he may successfully solve the conditions peculiar to his individual problems—with science as a servant rather than a mystery.

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Theory and Practice of Fractionation In Natural Gasoline Plant*

By L. S. GREGORY

NATURAL gas is composed mainly of the following paraffin hydrocarbons: methane, ethane, propane, butane, all gases at normal atmospheric temperatures, pentane, hexane, heptane and octane. Natural gasoline contains from a trace to 5 per cent. of propane, 0 to 40 per cent. butane, 15 to 40 per cent. pentane, remaining per cent. composed of hexane, heptane and octane. There are of course natural gasolines on the market which do not fall in the above classifications, but the volume of these gasolines is small and further mention of them will be neglected in the following discussion.

The natural gasoline manufacturer of today is confronted with the problem of making economically a gasoline from the gas containing all the pentane and heavier possible, with as much butane as his marketing specifications will allow, and a minimum amount of propane and lighter. The new A. S. T. M. specifications for Engler distillation (receiver at 32-34) in 1925 permitted a gasoline of higher butane content to be marketed. This gave impetus to any manufacturing method which would yield a gasoline having a high per cent butane content. The present trend of demand seems to be for a gasoline having a low per cent. butane.

A manufacturer usually does not know when a close separation is being obtained. The common methods of testing: vapor tension, Engler distillation, and gravity, leave much to be desired. Not because the theories behind these methods of testing are inherently wrong, but because an accurate interpretation of the results is difficult. Analysis of the gasoline is just being introduced to the industry and few companies are able to take advantage of this more specific method of testing. An intelligent control of the separation of the desirable components of the natural gasoline from the undesirable demands an accurate and readily interpretable method of testing.

The oldest method of separation, weathering or simple distillation, left much to be desired in economical separation and lived a long life because the manufacturer was interested only in reducing the vapor tension and increasing the recovery and had slight regard and knowledge for what was lost by such a method. A material balance based on an analysis of the gasoline before and after weathering would have shown the amount of valuable gasoline that was thrown away.

Economic Pressure

As economic pressure increased, improved methods of separation were introduced to the industry; vent tank separation, recycling, and finally fractionation in its various forms. What has been said above about methods of testing goes double for control of fractionators. Gravity, vapor tension, and Engler distillation are of great use in routine operation of fractionators, but for operation of new plants, trouble shooting, and as a final check, analysis of the gasoline is extremely valuable.

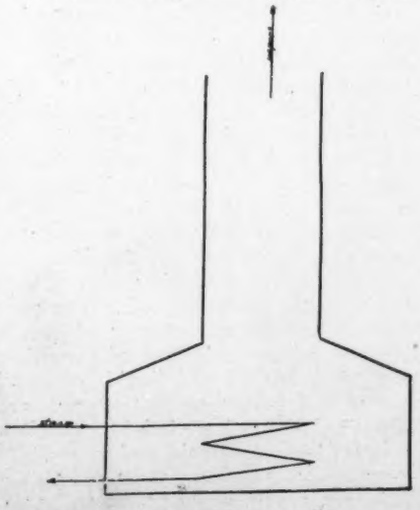

Figure 1

Fractionation is a term often used synonymously with dephlegmation, stabilization and rectification. Dephlegmation in the narrow sense is a separation by means of partial condensation and simple distillation. Rectification is separation by interaction of hot vapor rich in high boiling component with condensate poorer in the high boiling component, thereby evolving a cooler vapor richer in the low boiling component. Fractionation refers to separation by the combination of rectification and dephlegmation. Rectification is also used to designate the application of fractionation in the alcohol industry as is stabilization to the use of fractionation in the natural gasoline industry. Stabilization in some instances is a misnomer. Under certain conditions it is possible to manufacture by means of stabilization a high butane content gasoline having the same Engler recovery as a weathered product from the same feed stock which will show greater evaporization losses than the weathered product. Therefore in this case the so-called stabilized gasoline is in truth less stable than the weathered gasoline.

Dephlegmation

Figure 1 depicts a kettle equipped with a steam coil surmounted by a column. If the kettle is charged with

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a 500 gallon mixture of 20 wt. per cent. butane and 80 wt. per cent. pentane and the charge boiled or weathered, vapors will be evolved from the liquid richer in pentane due to the higher volatility of butane compared to pentane. If the liquid is boiled until the butane content drops to 10 per cent. in the liquid and all the vapors evolved during this boiling or weathering operation are condensed the condensate will have a volume of 173 gallons and a butane content of 39.3 per cent., a decided separation of the butane and pentane. This condensate may be returned to another kettle and boiled or weathered down to 10 per cent. butane and the residue returned to the original kettle. Separation may be obtained in this manner, but it involves an enormous number of distillations and a great heat consumption.

If the vapors ascending from the kettle are partially condensed in the condenser shown in figure two the partial condensate will contain a higher per cent. of pentane than was present in the vapors. The component having the lowest volatility condenses out in larger volume than the more volatile component. This allows a further separation to be made without additional consumption of heat, but instead a removal of heat. Such an operation is known as dephlegmation.

The condensate from the partial condenser is not by any manner of means in equilibrium with the vapors ascending from the kettle, but has a higher per cent. butane and lower boiling point. Therefore if the vapors coming from the kettle are allowed to mix with the condensate an interaction takes place in which the condensate boils, giving off a vapor higher in butane and the vapor from the kettle condenses in part, forming a liquid with a higher pentane content than the original condensate. The net result is that a vapor of a higher per cent. butane is evolved and a liquid richer in pentane is formed; in other words, a further separation is accomplished. An apparatus for such a process is known as a rectifying column, or in this special illustration, figure three, as a perforated plate column. The process of the interaction of the hot vapor from the kettle with the partial condensate having a lower pentane content forming a vapor richer in butane and a condensate richer in pentane is known as rectification.

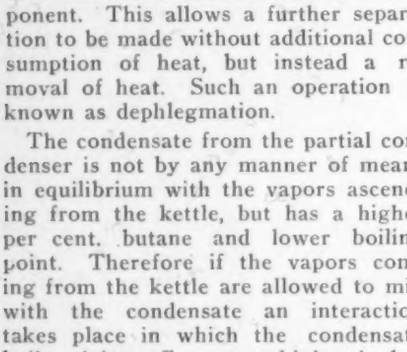

Figure 2

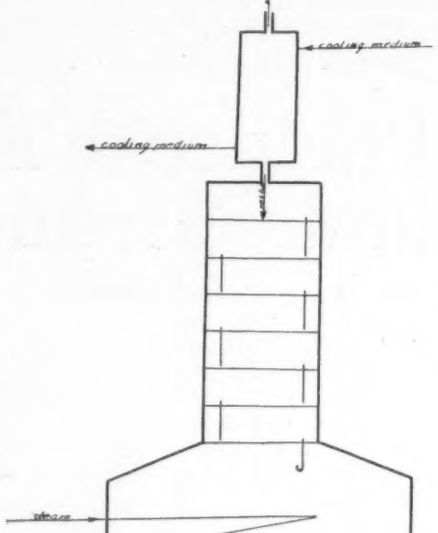

Figure 3

The detail and construction of rectifying columns varies and are determined by various controlling factors in each installation. There are two important types, the plate and packed column. The plate column consists of a number of plates arranged at right angles to the long axis of the column. There are a number of modifications of this type, such as bubble cap, perforated plate, etc., but the principle is the same for each. Every plate has means for allowing the ascending vapor to contact with the liquid held on the plate and a method for returning the excess liquid to the plate beneath. The plate column has the advantages; of ease of control, minor variations of conditions are taken up by the liquid on each plate; and better separation per unit distance of vertical height, excellent contact between liquid and vapor.

The packed column consists of a column filled with some kind of packing; crushed stone, steel shavings, Reichig rings, similar to small nipples. The advantages of a packed column are low pressure drop and generally low first cost. The disadvantages are: sensitivity to slight variation in operating conditions; the possibility of chanelling, that is the descending liquid forms a definite path down the packing or even side of the column, yielding but poor contact with the ascending vapor. The diameter and length of the packing material should be small in respect to the diameter of the column. This minimizes chanelling and provides a large surface for contact between liquid and vapor.

The Perforated Plate

Figure 3 is a perforated plate column. Each plate is perforated, so as to allow the hot vapors to pass up into the liquid on the plate, and is equipped with a down flow pipe. The upper end of the down flow pipe projects a short distance above the plate in order to maintain a depth of liquid on the plate. The lower end dips into the liquid on the plate below, forming a seal. The hot vapors from the kettle pass up through the perforations and condense in part on the first plate, boiling the liquid on this plate. A vapor is evolved richer in butane and a liquid richer in pentane is returned to the still through the down flow pipe. The vapor passes up through the next plate, condensing and boiling the liquid, and so on up the column until the vapor from the top plate passes into the condenser, where it is partially condensed. The partial condensate richer in pentane than the vapor and known as the reflux is returned to the top plate.

As a summation there is in the kettle a charge of pentane and butane which is boiled, forming a hot vapor that in-

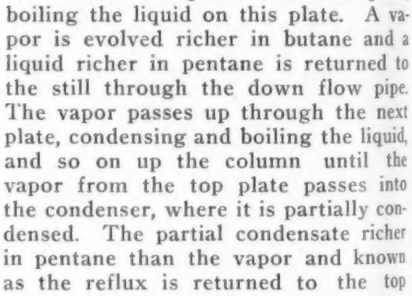

Figure 4

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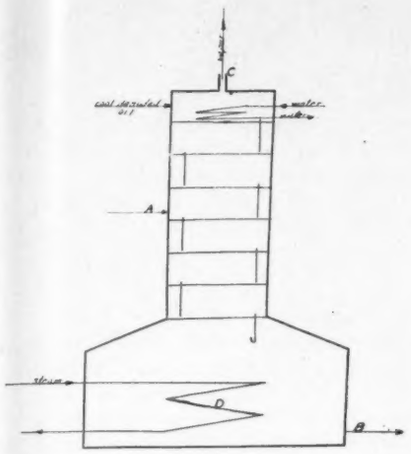

Figure 5

teracts on each plate with the liquid on that plate progressively, evolving a vapor richer in butane that finally passes into the partial condenser. The partial condenser effects some separation of the pentane from the vapor by the formation of the reflux. The liquid reflux passes down the column, forming progressively from plate to plate a liquid richer in pentane which finally flows into the kettle. The column therefore has a concentration gradient from plate to plate, highest pentane content in the kettle decreasing up the column until on the top plate, if vigorous fractionation is present, there is only a trace of pentane. It is obvious that there is also a temperature gradient in the column. The liquid on each plate boiling at a lower temperature than the liquid on the plate below. The partial condenser is at a slightly lower temperature than the liquid on the top plate.

The fractionation of the butane-pentane mixture may be carried on until the butane content of the kettle is only a trace, while the vapors drawn off are practically pure butane. Thereby, separation of the butane and pentane is accomplished with low heat consumption and quite simple apparatus. The above process is known as batch fractionation and is little used in the industry except in the case where a special cut is desired.

In common practice continuous fractionation is used. The feed, that is the raw gasoline, is introduced on a plate having a similar composition. The product marketable gasoline is withdrawn from the kettle continuously and the vapors leaving the partial condenser contain the lighter components of the feed that are not incorporated into the marketable gasoline.

The raw gasoline is of course of a more complex nature than the butane-pentane mixture discussed above, but the principle is exactly the same. The lighter low boiling components tend to pass up the column, the heavier high boiling components tend to pass down the column, forming a temperature and concentration gradient. Thus by means of intelligent design and control of fractionators separation may be accomplished any place that may be desired, within commercial limits, between the high boiling fraction and the low boiling fraction of the raw gasoline.

The Fly Wheel

For the smooth operation of fractionators the feed from the plant should be maintained as constant in composition and volume as practical. Variation in the concentration of the feed disturbs the concentration gradient established in the column and therefore tends to hinder efficient separation. Fluctuations in the volume of feed effects the ratio of the liquid flowing down to vapor passing up the column and therefore also hinders separation. The pressure and temperature of the kettle determines the volatility of the product and it is therefore obvious that they should be held constant. Temperature control is improved by maintaining a constant kettle level. The reflux is of great importance to efficient separation, and the amount of reflux should be ample and fairly constant. The reflux is figuratively the fly wheel of the fractionator, and if it is ample will tend to take care of small variations in feed. If the volume of reflux is too small an appreciable amount of the higher boiling components will be carried out in the vapor. If the volume is too large the column will flood, that is the column will fill completely with liquid. This liquid will be carried up through the condenser and out into the vapor line, causing much grief.

Flooding is not alone due to too much reflux, for there are several other causes, such as sudden increase in kettle temperature, sudden decrease in pressure at the top of the column, or rate of feed too great for the capacity of the column.

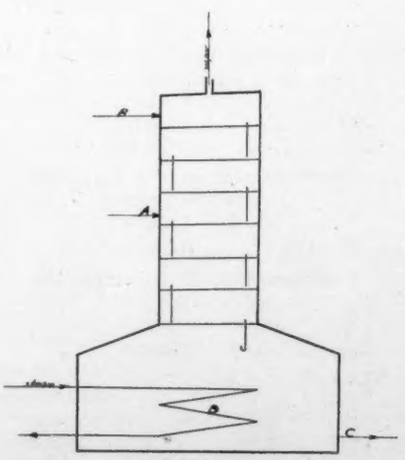

Figure 6

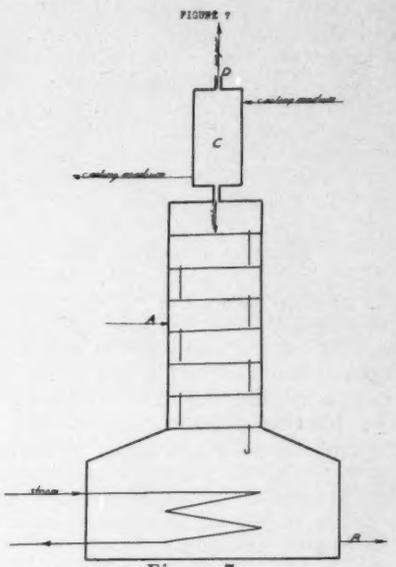

Figure 7

Fractionation is a proven economical method for separation of the lighter fraction from the heavier fraction. There have been several other methods used; weathering, vent tank separation, and recycling of the plant vapors. Weathering or simple distillation is the basic step in fractionation, but lacks the economical sharpness of separation that fractionation possesses. Vent tank separation is obtained by installing vent tanks between the sections of the oil heat exchanger and returning the vapors collected by the vent tank to some prior point in the plant. This method is usually cumbersome and rarely yields the sharpness or flexibility of separation that is desired. Recycling is similar to fractionation except in detail. The separation obtained by recycling may be as sharp as that produced by fractionation. Except for plants that are greatly underloaded recycling is not to be recommended as the only means of separation.

There are numerous methods of fractionating which at first seems to be entirely different from each other, but on inspection reveal the same basic principles. Four methods that possess most of the important modifications in the fractionation of natural gasoline are: fractionation of the gasoline and gas, fractionation of the rich oil, fractionation of the rich oil and gas, and fractionation of the gasoline. In the first three methods the feed is the raw gasoline diluted with gas or mineral seal oil, in the fourth method the feed is the raw gasoline from a compression, absorption, or charcoal plant.

Figure 4 is a diagramatic sketch of the apparatus for the fractionation of the gasoline and gas. The hot compressed field gas is introduced as a feed into the column, point A, the marketable gasoline is withdrawn from

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the kettle, point B, and the light undesirable components are removed as a vapor, point C. The mixture in the kettle is boiled by means of the steam coil D, and the condenser E at the top of the column is water cooled. It is important to note that two processes are performed within the column, extraction and fractionation.

Fractionating Rich Oil

Figure 5 is a diagramatic sketch of the apparatus for the fractionation of the rich oil. The rich oil from the absorber is introduced into the column as a feed, point A. The hot rich oil, with a smaller per cent. of the volatile fraction than is present in the rich oil used as a feed, is withdrawn from the kettle, point B, and pumped to the oil still. The extremely volatile fraction passes off as a vapor, point C. The kettle is equipped with a steam coil D. Cooled denuded oil is fed to the top of the column to form a reflux. Usually a water coil E is installed in the top of the column to remove the heat of absorption formed by the absorption of the vapors in the denuded oil. Efficient operation of this type of fractionator is said to remove the necessity for a recompressor. It is the writer's understanding that there are several such installations in operation in the California fields.

Figure 6 depicts the apparatus for the fractionation of the rich oil and gas. The compressed field gas is introduced into the column as a feed, point A. The denuded oil is injected at the top of the column, point B, forming an absorbent and refluxing medium. The hot rich oil containing only the gasoline desired as a final product is removed from the kettle, point C, and passed to the oil still. The kettle is equipped with a steam coil D. The reflux is produced by the absorption of the gasoline by the lean oil at the top of the column. In this method the column performs a double function of absorber and fractionator. Efficient operation of this type is said to remove the necessity for a recompressor.

The apparatus for the fractionation of gasoline is shown in figure 7. The raw gasoline from a compression, absorption, or charcoal plant is introduced in the column as a feed, point A. The marketable gasoline is withdrawn from the kettle, point B. The light undesirable fraction is withdrawn from the reflux condenser C, at point D.

Fractionation of the raw gasoline is divided into two classes, high and low pressure fractionation. The classification is not sharp and a certain installation may fall into either class, depending on the viewpoint. In low pressure fractionation the recompressor condensate is usually expanded into the top of the column to give the low reflux temperature necessary when a low column pressure is employed. This means of cooling does not possess the sharpness of separation that may sometimes be desired. The recompressor condensate contains some of the heavier components and since it is introduced into the top of the column it is not rectified and therefore some of the desirable gasoline passes off in the vapor withdrawn from the top of the column. A more efficient separation may be obtained by introducing the recompressor condensate as a secondary feed on a plate having a similar composition; this will of course be above the primary feed plate, and recompressing the vapors from the top of the column. The condensate from this recompression may be expanded into the reflux condenser to produce the required low reflux temperature. In high pressure fractionation the reflux temperature is usually above the temperature of the cooling water available. Therefore water forms a very satisfactory cooling medium for a reflux condenser on a high pressure fractionator.

Insulation

Insulation of rectifying column is important. This is especially true of high pressure fractionators. An uninsulated high pressure column will act as a condenser throughout its length, for the atmospheric temperature is usually lower than the temperature at any

TABLE 2

*Field Gas G.P.M.	Pressures—Lbs. per Square inch Gage		Temperatures, °F Ranges For rectification Kettle for column top for				Oil Circulation To Absorber for		Gals. per day To Top of Column for		Gals. Gasoline in 100 gals. of Enriched Oil Leaving Kettle for	
	Rectifying Column	Absorber	Grade AA	Butane Free	Grade AA	Butane Free	Grade AA	Butane Free	Grade AA	Butane Free	Grade AA	Butane Free
Fractionation of Gasoline and Gas												
2.7	300	...	300	370	85	100	.....	.....	.....	.....	...	...
2.0	300	...	300	370	90	100	.....	.....	.....	.....	...	...
1.0	300	...	300	370	95	100	.....	.....	.....	.....	...	...
Fractionation of the Rich Oil												
2.7	5	35	265	...	...	...	127920	.....	7520	.....	8.45	...
2.7	0	35	240	370	...	...	130360	143400	9960	23000	8.27	4.7
2.0	0	35	265	400	...	...	127800	137280	7400	16880	6.27	3.64
1.0	0	35	340	480	...	...	124100	128930	3700	8530	3.22	1.93
Fractionation of the Rich Oil and Gas												
2.7	0	0	355	...	...	...	376000	.....	376000	.....	2.88	...
2.7	35	35	360	500	...	...	111500	115200	111500	115200	9.38	5.85
2.0	35	35	395	above	500	...	113900	.....	113900	.....	7.01	...
1.0	35	35	500	above	500	...	117000	.....	117000	.....	3.42	...
Fractionation of the Gasoline												
2.7	10	35	85	150	15	45	120400	.....	.....	.....	...	...
2.0	10	35	85	150	15	45	120400	.....	.....	.....	...	...
1.0	10	35	85	150	15	45	120400	.....	.....	.....	...	...
Fractionation of the Gasoline												
2.7	175	35	245	315	135	180	120400	.....	.....	.....	...	...
2.0	175	35	245	315	135	180	120400	.....	.....	.....	...	...
1.0	175	35	245	315	135	180	120400	.....	.....	.....	...	...

4,000,000 cubic feet field gas employed in each instance.

Temperatures are entered in the table to the nearest 5°

*See table 1 for composition of gas.

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point in the column. This condensation effect in a bare column greatly hinders efficient separation and if very great will cause the column to flood. In a low pressure bare column the absorption of heat will put a greater load on the recompressor to provide the necessary amount of cooling.

The methods described above are compared by calculating the operating conditions required to produce a grade AA, having the following composition: 35 wt. per cent. butane, 36.7 wt. per cent. pentane, and 28.3 wt. per cent. heavier, and a butane free of gasoline from three different field gases. The analyses of the three field gases employed are shown in table 1. Field gases A is an actual analysis of a field gas. Field gases B and C are calculated analyses from field gas A. The two calculated analyses are probably higher in butane and propane than an actual gas of the same G. F. M. value, due to the fact that the percentages of all components lighter than pentane were increased proportionately to make up for the decrease in the percentage of the pentane and heavier. Due to the high butane and propane content of the leaner gases the calculated top temperatures or reflux temperatures are higher than would be expected from a lean gas. Table 2 is a tabulation of the operating conditions for the different methods.

The following conclusions may be drawn from table 2: Fractionation of the gasoline and gas, fractionation of the rich oil, and fractionation of the rich oil and gas, are generally only applicable to cases where there is a rich field gas, and a desire for only a narrow range of products. Fractionation of the gasoline may be applied successfully to a plant working on a very lean or very rich gas, and a wide range of products may be had. High pressure fractionation is usually more desirable because the reflux temperature may generally be controlled easier and more economically than is the case in low pressure fractionation. High pressure fractionation does away with the possibility of the column freezing. This simetimes happens in a low pressure column when a damp feed is employed.

Conditions in the industry have only recently made a knowledge of fractionation of interest or profit to the manufacturer, but its future seems to hold great promise and the fractionation of gasoline is evidently here to stay. By the use of fractionation a gasoline may be made that is suitable for an aviation gasoline. This supplies a direct market for its product. A highly volatile liquid suitable for a gaseous fuel or as a base for by-products may be made from the light fractions. If a special cut from the gasoline is desired, fractionation is the answer. Fractionation is a tool that the natural gasoline manufacturer can use to make a gasoline that will meet any reasonable grade specification or percentage composition analysis.

TABLE 1

	Field Gas A	Field Gas B	Field Gas C
Methane	44.0%	44.4%	45.2%
Ethane	26.1	26.4	26.8
Prepane	16.5	16.7	17.0
Butane	9.2	9.3	9.4
Pentane	2.7	2.02	1.01
Hexane and heavier	1.5	1.12	.56
G. P. M.	2.7	2.0	1.0

The G. P. M. value is based on 100 per cent. extraction of pentane and heavier and the butane necessary to form a 35 wt. per cent. butane gasoline.

Theory and Practice of Automatic Control*

By T. G. LANEY
Fisher Governor Company

THE natural gasoline industry has progressed from a small beginning less than twenty years ago to an industry of large values. During this period, the improvement in the manufacture of both pressure and temperature controls has also gone forward rapidly. The growth of these two industries has progressed hand in hand, the engineers of both industries have given their time, and the necessity of control being evident, the money has come forward to meet the expense of development.

The industry started some years ago with pressure reducing valves for the control of gas to the engine and a back pressure valve to hold the pressures on the system constant. These few controls were all that were required on the compression plants. With the introduction of the absorption process, temperature controls came into prominence and closer regulation of tempertures and pressures resulted in a higher efficiency being obtained and with an improvement in the product being produced. Now the stabilizer has come forward with additional problems of regulation to be solved.

During this period of rapid development with the introduction of new applications, there has been a constant desire on the part of the control manufacturers to improve their equipment. This general improvement of equipment made it possible for the gasoline manufacturer to improve his product, reduce his labor cost, and increase the efficiency of his plant. It can be said without any hesitancy that there has been a greater application of automatic controls to the manufacture of natural gas gasoline than to any other industry.

In order to emphasize the complexity of the problem facing the designer of automatic control apparatus, allow me to digress for a moment into a short discussion of some of the physical laws which may be used to give us a better understanding of the effect of changes of temperature and pressure on the different operations used in connection with the manufacture of natural gasoline and why it is so necessary to control them within narrow limits.

One Rule Applies

Underlying all of this application of automatic controls of both pressure and temperature, there is a rule, first stated by Willard Gibbs, known as the phase rule. This rule applies to every operation in the manufacture of natural gas gasoline. The meaning of the phase rule can be best understood by studying it in connection with simple substances which exist in different states of aggregation, solids, liquids, and gases. The different modifications of a substance, and we, therefore know most substances in three phases. It may occur that the same substance exists in more than three phases, there being two or more phases in the same state of aggregation.

Those phases may exist separately, the phase depending chiefly on the temperature and also to a considerable extent on the pressure, or they may coexist in a condition of equilibrium with one another. Take a common substance like gasoline. At all ordinary temperatures and pres-

*Before annual convention of the Association of Natural Gas Manufacturers, Hotel Mayo, Tulsa, Oklahoma, May 22, 23 and 24, 1928.

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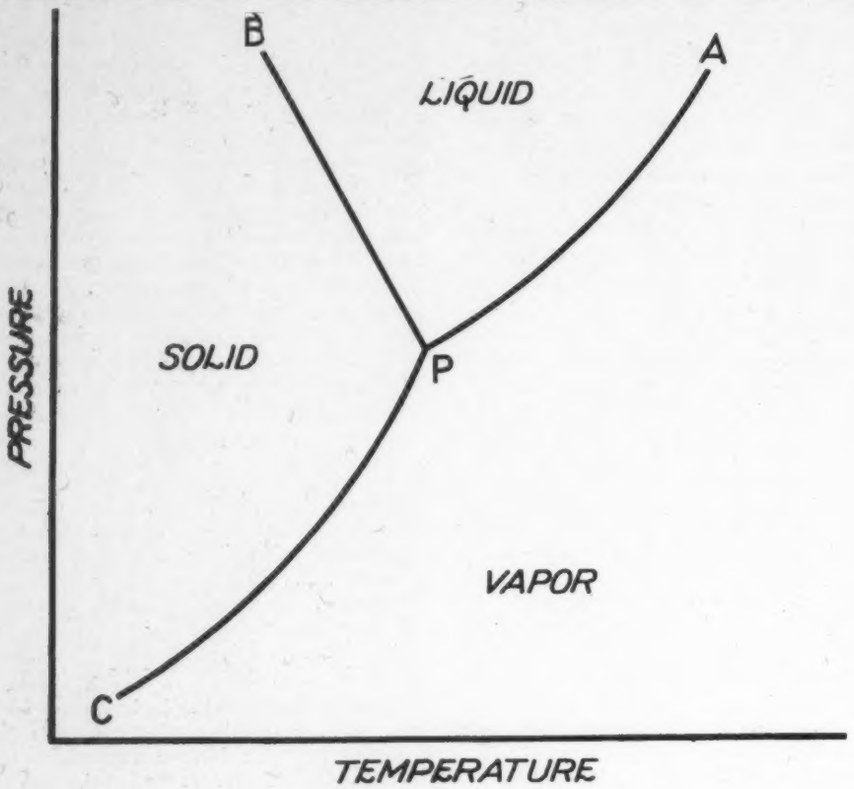


sures, it exists both in the liquid and vapor phase. At each given temperature, the vapor is formed until it acquires a definite pressure, and when this is reached, we have an equilibrium between the liquid and vapor phases.

If we determine the vapor pressure of gasoline at different temperatures, and then plot the curve expressing the relation between temperature and vapor pressure, it would have the following form:

The abscissas represent temperature and ordinates, pressures. The curve represents conditions of equilibrium between liquid phase and the vapor phase. Below the curve, we have only the vapor and above, only the liquid in a condition of stable equilibrium.

This is a very simple example but serves to show the meaning of the term phase, and of equilibrium between different phases.

Applying the Rule

Let us now take a substance that exists in three phases; a very good example being water. Water exists in the form of solid, liquid, and vapor, depending chiefly on the temperature and, also on the pressure. If we draw the temperature pressure curves representing the conditions of equilibrium between the different phases of water, the curves would take the following form.

The line PA represents the condition of equilibrium liquid water and water vapor. Below this line, the vapor is in the stable phase, above it the liquid. The line PB is the line of equilibrium between the liquid and the solid phase of water, the liquid being the stable phase to the right of this curve and above the curve PA, while the solid is the stable phase to the left of PB and above PC. The curve PC is the line of equilibrium between the solid phase of water and water vapor; above this curve and to the left of PB is the stable condition, while below PC and PA, water vapor is the stable phase.

It will be observed that the three curves intersect at point P. This point has properties that make it of special interest. Since it is common to all the curves, it means that at this point the three phases have the same vapor pressure. This point is known as a triple point.

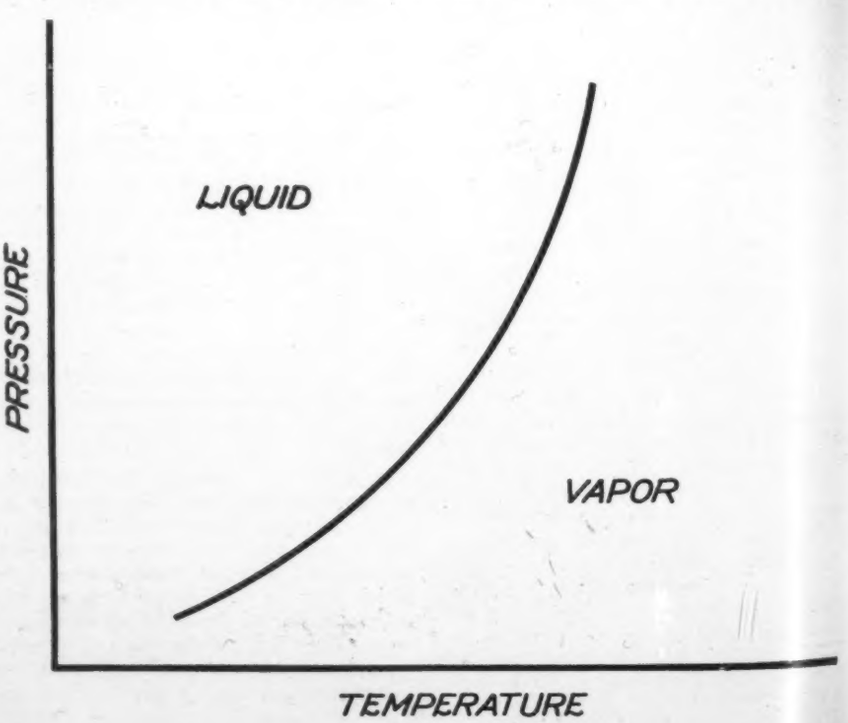
We can now state and apply the phase rule. If the number of phases exceeds the number of components by two, the system is non-variant or has no degree of freedom. This means that none of the conditions can be varied without destroying the equilibrium. The triple point P is an example of a non-variant system. The number of phases, three, and the number of components, one, we connot vary either the pressure or the temperature without destroying the equilibrium between the three phases.

If the number of phases exceeds the number of components by one, the system is mono-variant. This is the case of the system PA, PB, and PC. The number of phase is two, and the number of components one, and there exists one variable along these curves. We can vary either temperature or pressure provided we keep on the curve without destroying the equilibrium between the two phases.

In Natural Gasoline

You are now able to see how fully the phase rule applies to the natural gasoline industry. Take your boiler, the water changes from a liquid phase to a vapor phase due to an increase in temperature which results in an increase in pressure. This change of phase could be controlled by either a temperature or a pressure regulator. As your steam passes on its way to the still or pumps, you drop your pressure through a reducing valve where you have a drop in pressure and temperature.

In the still, there is a change of phase from an aggregate of two components,



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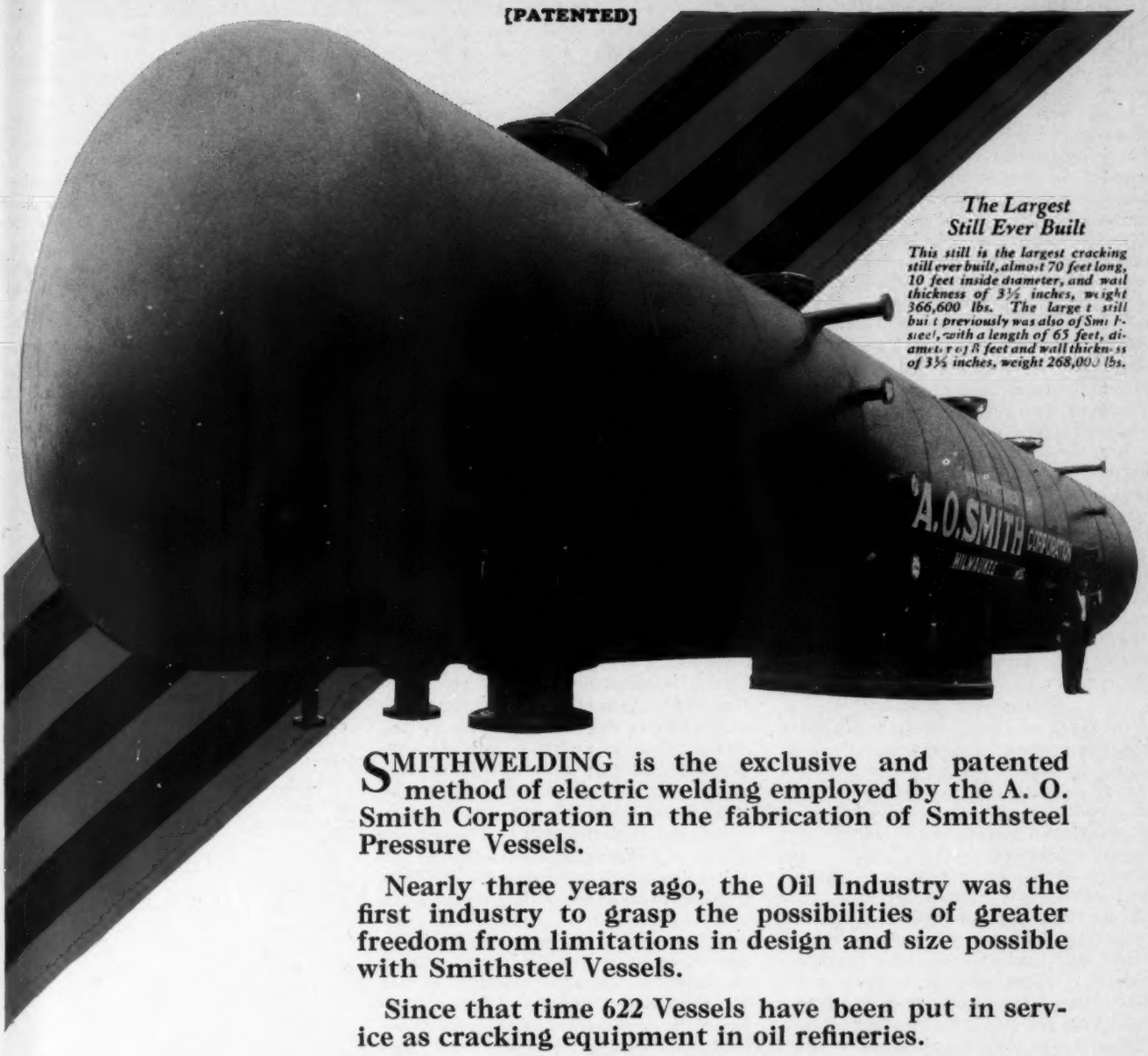

The Largest Still Ever Built

This still is the largest cracking still ever built, almost 70 feet long, 10 feet inside diameter, and wall thickness of 3½ inches, weight 366,600 lbs. The largest still built previously was also of Smithsteel, with a length of 65 feet, diameter of 8 feet and wall thickness of 3⅛ inches, weight 268,000 lbs.

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the absorbing oil and gasoline, to two single compounds. The gasoline changes its phase back to a liquid with a change of temperature. This condensation could be accomplished by a change of pressure.

In your stabilizer, you change the state of some of the components of the aggregate in order that you may more readily separate the component parts of the gasoline. By holding the temperature and pressure of the gasoline being treated at a predetermined point, the butane and propane pass from the liquid phase to the vapor phase. This accomplished by dropping the pressure below the pressure corresponding to a temperature which gives stability or by raising the temperature above this point of stability holding the pressure constant.

Any of the changes of phase that take place in the system can be controlled from either the temperature or the pressure point or view or a combination of the two. As an example, take the knock out box or dephlegmator which is used to control the end point of the gasoline. The pressure is held constant and the temperature of the gases leaving this partial condenser is controlled. If it were more economical, this change of phase could be accomplished by compressing the vapors to a higher pressure and holding the temperature constant.

Multiplying Pressure

In many of these changes of phase, the temperature or pressure variable is often too small to use as a control factor. As an example, the control of pressure in a boiler by turning on and off the gas. A one pound change in pressure of the steam corresponds to one half degree change in temperature at one hundred and twenty-five pounds pressure. The change in temperature is so small that most instruments would not act on it. This, then resolves itself into a pressure control problem and by multiplying the one pound pressure change by the use of a diaphragm, it becomes very simple. There is also the case where air or other gases are included with the steam which causes the temperature to vary from what it would normally be at a given steam pressure if they were not present. Yet, where a constant temperature is necessary and the amount of heat being carried away is variable, a temperature control is necessary. This last condition is met with in a great many cases.

In all regulator action, the regulator must follow the change as it takes place. If one could design a regulator that could see and think, adjusting itself to the changes at the very start with variable intensity to meet the requirement, the problem of regulation would be solved. This ideal is not possible, the regulator must wait till a change has started before it can move to meet the condition. A well designed regulator moves to adjust the condition as soon as a change occurs and moves thereafter in small increments of its total movement until the change is caught and started back to the controlled condition. You can clearly see that snap actions are to be avoided. That is, actions that move the controlling valves through large changes with small variations of pressure or temperature. The name commonly used to describe this action is open and shut.

It must be kept in mind that the movement of the valves must be great enough to catch or over ride the change that the control is to correct, or the correction will not over ride the error and correct it. Most regulator manufacturers design their valves with this in view. But more often than not, the purchasers buy valves of the same pipe size as the line, without consideration of the volume the valve is to handle. For instance, a consulting engineer in New York City, during the war, could not get a twelve inch valve to go in a twelve inch line. The manufacturer of the valve could only supply four inch valves and only two of these. Much to the surprise of all concerned, it developed that one four inch valve was ample for most of the load and the second valve was hardly ever used. This is not unusual; in fact, it would surprise you how common an error this is.

One other point in regard to the sizing of the valves; valves are merely adjustable orifices and for the purpose of sizing can be considered as such. If a large drop in pressure is contemplated, a smaller valve can be used than if the pressure drop through the valve is small. You will find that several manufacturers build valves with equal sizes of pipe connections but with different size of inner valves and port openings.

Differential Control

A rather novel application that has lately arisen to some extent in gasoline work is that concerned with differential temperature control. It is claimed by many that in gasoline fractionation a factor conducive to efficient fractionation lies in maintaining a constant differential between the temperature of the vapors entering and leaving the column. In other words, if the temperature of the vapors entering the condenser should go a certain number of degrees above an established point, the material leaving the condenser should likewise show this same increment of temperature increase, and vice versa. It would then be desirable to have an instrument with such characteristics of operation that with the decrease in temperature of the vapors entering the condenser, the instrument, through the control valve in the water line, would increase the supply of cooling water to the condenser; correspondingly, an increase in temperature of vapors entering the condenser would restrict the supply of cooling water to the condenser to allow the material leaving to rise to the temperature desired.

A few years ago, there was placed on the market, an unusual valve which is of considerable help to plants in new fields that are using gas from flowing wells. As all of you know, who have operated plants under this condition, the gas comes in heads, which are often of such size as to overload the plant's engines causing them to stop. This is due to the pressure being raised on the intake to the compressors. This problem was met by placing in the suction line, a diaphragm controlled valve that closed from an increase above a certain predetermined pressure on its discharge side and stood wide open at all pressures below this set pressure.

Such special valves to meet new conditions are not unusual problems to be put before the manufacturers of this type of equipment. Often the manufacturers are able to forsee some special condition that is to be met and brings to your attention a method of meeting your problem. Let me urge you to submit your problem to a reputable manufacturer, who will gladly work out, often at great expense to his company, the instrument necessary to meet your condition.

Doctor Test Added to Natural Gasoline

Tulsa, Oklahoma—The "sweet to doctor" requirement has been added to specifications of the Natural Gasoline Association of America. The decision was reached at the meeting of the board of directors here during the seventh annual convention.

The statement on this subject follows:

"At a meeting of the Board of Directors of the Natural Gasoline Association of America held on May 24, the clause, "sweet to doctor," was added to the specifications of the Association and at an early date all natural gasoline falling under the specifications of the Association must be "doctor sweet."

"Perhaps no problem of the Association has been given more serious consideration than the question of making "doctor sweet" natural gasoline a part of the official specifications. The demand for sweet gasoline has been large for the past several years, most refiners demanding it both for domestic and export uses.

"The directors of the Association appreciate that there is a movement of sour gasoline and that quotations on that grade of material should be carried in trade papers apart from specification gasoline as long as there is a considerable movement of that grade.

"The cost of making natural gasoline, "sweet to doctor" is remarkably low. The Natural Gasoline Association of America will be glad to furnish treating costs, methods of treating and any other aid of those who wish to equip with treating plants.

"The Board of Directors of the Natural Gasoline Association has requested the Specifications Committee to set a date on which the new specification will become effective and also to determine the method which shall govern the test."

NATURAL GASOLINE ASSOCIATION OF AMERICA

Gas Lift and Repressuring and Their Relation to Natural Gasoline Industry*

By H. B. BERNARD
Vice-President of Sinclair Oil & Gas Company

WHEN your program committee called on me to present this paper I told them that in my opinion the subject matter was so entirely obvious that a paper on it would be merely a re-hash of existing conditions. In answering me they stated that the matter was not as obvious as I supposed and were kind enough to furnish me a number of interrogatories on the subject around which I have attempted to build this paper.

In the first place neither the gas lift nor repressuring is new when considered either as entities or taken in relation to natural gasoline production. It is only, however, within the past year or so during which time so much attention has been focused on the Seminole field that the subject of this paper has received widespread consideration. In view of the fact that the largest installations exist in the Seminole field and that all past experience has been concentrated in the development of this idea, the subject matter of my paper will lay most stress on operation in the district which is most in the public eye, depending, however, on lessons learned during the past few years to build up a background for the present.

About five years ago my company put into operation a repressuring project using the high pressure gas available at one of its old compression gasoline plants. Over a period of years it was noted that not only an increase in oil production resulted, but that year after year a corresponding increase in gasoline production at the gasoline plant was obtained. To illustrate the length to which this operation has gone I would say that this particular gasoline plant which is now in its eleventh year had its peak production for all time during the year 1927, and for the first three months of 1928 the production exceeded that obtained during the corresponding period of previous years.

With this lesson before us my company constructed another compression plant just two years ago and conceived it with the idea that it would be used not only to extract gasoline but would serve for gas lift, repressuring and gas marketing purposes. I can merely say that after two years operation this plant has admirably fulfilled its destiny not only to the benefit of my company but also to that of other operators in the field from whom raw gas is being purchased and who have taken advantage of the opportunity offered to store in the partly depleted sand the excess residue available after gasoline extraction and normal plant and lease operating requirements.

The problem of gas lift and repressuring with relation to the manufacture of natural gasoline is solely an economic one, that is, it is a matter of dollars and cents efficiency and not one of mechanical and operating efficiency. A plant might be constructed and operated to profitably lift a given amount of oil and produce a given amount of gasoline. Through additions it is conceivable that the plant may increase both the oil and gasoline production, but if the value of the additional oil and gasoline is less than the cost required for its production it certainly cannot be construed as a profitable operation. In other words the problem of gas lift and repressuring with or without the relation to natural gasoline production is the reduction to possession of the maximum profitable quantity of crude oil, natural gasoline and gas.

The first consideration to be given to the method of oil production is the manner in which that oil can be put in the tanks at the lowest possible cost. In a properly designed gas lift plant the production of gasoline will be concomitant with the production of crude oil, but it is easily conceivable that such gasoline production will not be profitable because of the fact that as produced at the gas lift plant the gasoline might have no value or in fact might even have a negative value, that is, further expenditure is now necessary to prepare the gasoline for market through providing storage, transportation and loading facilities. Assuming the gasoline now delivered to the tank car, the most important phase of all is now entered into and that is the problem of marketing. It has been readily demonstrated and it is very much before us today that this excess gasoline produced as a by-product from gas lift operations can so affect the market structure that the total value of all the gasoline produced will be less than the value of the gasoline produced before the introduction into the market of the gas lift gasoline. In other words, not only might the gas lift gasoline be unprofitable to produce, but its production might easily cause the production of all other gasoline to be unprofitable.

I must lay particular stress on this problem of gasoline production from gas lift sources and the marketing of such gasoline. There is no question but that the present demoralized condition of our industry is due to colossal ignorance of market conditions on the part of both the producers and gasoline manufacturers.

The Gas Lift Plant

In its physical operation the matter of gas lift and by-product gasoline extraction is relatively simple. The average gas lift plant designed for the two-fold purpose is in effect nothing more or less than a compression gasoline extraction plant with only a few essential differences. Under ordinary operating conditions casinghead gas is brought to the plant through an orthodox gathering system, compressed in two stages to 250 pounds or 300 pounds, the gasoline being condensed out by coolers on the low and high discharges. Instead of now using the ordinary type of back pressure valve to maintain plant discharge pressure it might be said that the wells to be produced by the gas lift function as back pressure valves. Of course proper mechanical provision is made for the plant to operate at a pre-determined discharge, and by means of a devised system of individual well controls each well is assured of having a gas supply sufficient in quantity and pressure for its operation. Under normal operating conditions where the kick-off pressure is higher than that available at the plant each manifold system is equipped with a third stage unit which is in operation just so long as is necessary to start a well flowing.

On the average it has been found that the excess of gas produced over the quantity necessary for lifting purposes will about balance lease operating and development requirements. If the situation is complicated by the introduction of swabbing, pumping or natural flowing wells, a more elaborate scheme of gas handling and gasoline extraction is resorted to, but I do not propose to get into that matter in this paper.

In the interrogatory submitted to me there was brought out for elucidation in this paper a number of questions based on the general system as outlined herein and which were devised for the purpose of making this paper as comprehensive as possible. There will now follow the questions and my answers thereto:

Ques. 1.—*A compression plant does not completely recover all of the natural gasoline.*

Ans. 1.—From the oil production stand-

*Presented before the annual convention of the Natural Gasoline Association of America, Tulsa, May 22, 23 and 24, 1928.

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point the recovery of natural gasoline is secondary. From the gasoline producing standpoint it is quite true that the compression plant does not recover all of the natural gasoline, but neither would an absorption plant when it is considered its operations are conducted under flush conditions. In fact it has been demonstrated that under these conditions the compression system is more efficient from an extraction standpoint than is the absorption system.

Ques. 2.—The gasoline should not be recovered, but should be put back in the lift or repressuring system to aid in the complete recovery of oil.

Ans. 2.—This is not practical because the gas should be cooled to approximately atmospheric temperature. Cool gas gives a greater lifting effect than does warm gas and in addition warm gas would tend to distill additional gasoline from the oil which is just the reverse from the desired result. Of course it is understood that to get the gasoline in the gas back in the well the gas must be warm in order that the gasoline will be in a vapor state.

Ques. 3.—The gas lift is a temporary expedient which does not justify the compressor plant.

Ans. 3.—I can only say that experience has proven very much to the contrary. We have had repressuring plants in operation for five years and our oldest gas lift plants which have been in operation for two years are not only still performing their original function, but have recently been enlarged. In the Seminole field our original lift plant is over a year old and is still in operation.

Ques. 4.—What about the gas from wells flowing naturally?

Ans. 4.—As stated earlier in this paper, a natural flowing well offers a complication to the system if gasoline extraction is the primary object, if not the condition introduced by natural flowing wells can be disregarded. The gas from a natural flowing well is just as valuable and available to a gas lift as recycled gas.

Ques. 5.—The pressure drop from the plant to the wells will be too great to permit normal flowing.

Ans. 5.—Of course the area in which a central plant can be utilized is limited, but this feature can readily be predetermined by checking the cost of longer and larger lines against the cost of additional central plants.

Ques. 6.—Compression plants are more expensive than absorption plants to handle large gas volumes.

Ans. 6.—That is very true when considered from the gasoline extraction standpoint but where the gas lift or repressuring is considered it is quite to the contrary, because for these services the compression plant is required any way and gasoline extraction then merely becomes a secondary function.

Ques. 7.—The quality of compression gasoline is not as good as absorption gasoline.

Ans. 7.—There is nothing to this at all. The gasoline in a quantity of gas is the same gasoline no matter if it is extracted by compression, absorption, refrigeration or other means. In fact I incline to the belief that compression gasoline is a superior product because with it there is little or no trouble with high end point and off color, and in addition compression gasoline can be handled a lot cheaper than can the absorption product.

Ques. 8.—The central compression system impairs control of the production man over their wells.

Ans. 8.—As a matter of fact the reverse is true as there is always a large reservoir of gas available for any contingency or irregularity in operation. The work for the production man is greatly simplified and he is able to more efficiently and economically secure his production.

Ques. 9.—Portable compressors for gas lift can be moved in a short time to a different location.

Ans. 9.—The so-called mobility of the portable unit is so far over balanced by other considerations that this feature is the only thing that might be said in its favor. My own experience has been that we can handle large units easier and cheaper than we can the portable equipment. However, for kick-off work where a low capacity unit in intermittent service is required the portable unit is alright, only of course, in this application it is no longer portable but is as much a part of the operation as is the large central plant.

Ques. 10.—A large control plant cannot be justified in a new or unproven field.

Ans. 10.—That is perfectly true. As far as I know no effort has been made in making such an application.

Ques. 11.—Individual wells require not only different volumes, but different pressure for best gas lift results. Pressure delivery from the central plant is not high enough to permit manual or automatic variation to suit the character of each well or the state of its flow.

Ans. 11.—If the central plant was haphazardly designed this objection might be tenable, but if the maximum pressure required for flowing is considered the central plant with lease manifolds and kick-off units equipped with proper controls offers about as reliable and fool-proof an installation as I know of.

Ques. 12.—Air is less soluble in oil than gas and therefore builds up pressure better.

Ans. 12.—That is the very reason that gas is desirable. The fundamental conception is that oil is lifted through the expansion of the gas that has been absorbed in it. The use of gas as opposed to air means a lower operating pressure. On the other hand more gas is required to lift a given amount of oil as against the quantity of air necessary for the same operation, but it takes less horsepower to compress a given quantity of gas than it does the same quantity of air. Due to its comparative insolubility, air materially lessens the gravity of the crude oil, whereas gas might even increase the gravity of the oil. In addition to the foregoing the use of air is more hazardous than a strictly gas operation due to the danger of forming explosive mixtures.

Ques. 13.—During active drilling there is not enough gas for both fuel and gas lifts.

Ans. 13.—Under every operation I have experienced to date there is always ample gas for both operations as each barrel of oil always yields up a proportional quantity of formational gas.

Ques. 14.—The long gathering lines of a central plant tend to cause pressure on traps reducing oil production and efficiency of gas lift.

Ans. 14.—Back pressure on gas traps is a measure of efficiency rather than the contrary. While each individual operation must be handled as a unit in general it may be said that flowing against five pounds to 10 pounds is not in any way detrimental to gas lift operation. Five pounds on a gas trap merely increases the flowing pressure by 2 per cent. but at the same time increases the capacity of the flowing units between 15 per cent. and 25 per cent.

In closing I wish to again to impress on you that the problem of gasoline manufacture in its relation to gas lift is an economic one. I certainly am opposed to every Tom, Dick and Harry indiscriminately manufacturing gasoline from a gas lift operation for the reason that not only will the operator not derive any benefit from his operation, but he will do a lot of harm to those gasoline manufacturers who have a market for their product and are able to govern their operations with due regard for the available outlet. I will state without fear of successful contradiction that it is more profitable to let a lot of gas blow off in the air than it is to extract gasoline from that gas when by so doing a demoralized market is further gultted with a material that is produced far in excess of any reasonable demand.

PRIMROSE RESUMES

Wichita Falls, Texas.—Primrose Refining Company resumed operations of its Wichita Falls refinery May 1. The plant had been shut down for about one year. The 1,500-barrel plant will specialize in the preparation of special naphthas, rather than gasoline.

Plant operations is under the supervision of J. B. Joyce, formerly with the Simms Oil Company at Dallas, and the Texhoma Oil & Refining Company at Wichita Falls. J. F. Muense, formerly plant superintendent at Wichita Falls, is in charge of the refinery of the Primtex Refining Company, an affiliated company operating near Dallas, Texas.

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Supply Men Form Permanent Organization

Tulsa, Oklahoma—The Natural Gasoline Supply Men's Association was formed as a permanent organization here May 22, the first day of the seventh annual convention of the Natural Gasoline Association of America. The two organizations are affiliated in that membership in the former involves associate membership in the latter.

The permanent organization grew out of a temporary organization, formed last year to provide entertainment for the annual conventions of the Natural Gasoline Association. The purpose is restricted to that function. The constitution leaves the supply body the privilege of furnishing this entertainment only when the conventions are held in Tulsa. The constitution further pledges the members not to display equipment at these conventions.

The organization involved adoption of the constitution and by-laws, election of officials and selection of directors.

Officials are J. H. Satterwhite, Westcott & Greis, Inc., Tulsa; president; M. F. Waters, Smith Separator Company, Tulsa, first vice president; William A. Schlueter, Refinery Supply Company, Tulsa, second vice president; D. W. McKay, Hope Engineering & Supply Company, Tulsa, treasurer; and A. V. Bourque, secretary.

Directors are William G. Cummings, Gas Engineering & Supply Company, Tulsa; W. D. Emory, the Foxboro Company, Tulsa; W. B. Woobank Pump & Machinery Company, Tulsa; P. P. McKirahan, Continental Tank Line, Tulsa, as well as the officials of the association, and H. A. Trower, who as president of the Natural Gasoline Association of America, is a member of the Board of Directors, ex-officio.

All entertainment of the convention of the Natural Gasoline Association of America was furnished this year by the body of manufacturers and dealers of equipment Two noon luncheons were served. The entertainment of the second night consisted of a smoker. An elaborate theatrical program, with a meal served during the intermission, made the evening the high spot of the fun side of the convention.

The following concerns had joined the Natural Gasoline Supply Men's Associaation at the end of the convention:

American Car & Foundry Company, Atlas Supply Company, C. F. Braun Company, Bessemer Gas Engine Company, Bruce McBeth Gas Engine Company, Briston Company, J. A. Campbell, C. & G. Cooper Company, Chaplin Fulton Manufacturing Company, Clark Brothers Company, Continental Supply Company, Continental Tank Car Company, Chapman Valve Company, G. M. Davis Regulator Company, Dearborn Chemical Company, Engineering Research & Equipment Company, The Fisher Governor Company, The Foxboro Company, Hope Engineering & Supply Company, Hurley Brothers, Ingersoll-Rand Company, Magneto Ignition Corporation, Metric Metal Works, A. J. McEwan and Company, Inc., National Petroleum News, National Supply Company, North American Car Corp., The Oil & Gas Journal, Pittsburg Equitable Meter Company, Pennslyvania Tank Line, Refiner & Natural Gasoline Manufacturer, Refinery Supply Company, Smith Separator Company, Southwestern Engineering Company, C. J. Taglibue, Tulsa Boiler & Machinery Corp., Taylor Instrument Company, Vinson-Canter Company, Westcott & Greis, Inc., Westcott Valve Company, Woodbank Pump & Machinery Company, Worthington Machinery Corporation of Oklahoma.

CALIFORNIA GASOLINE ASSOCIATION

Los Angeles.—A new attendance record was established at the regular monthly meeting of the California Natural Gasoline Association, held Thursday evening, May 10, at the Alexandria Hotel. Nearly 400 members and visitors attended. E. G. Ragatz, refinery engineer for the Union Oil Company, read a paper on "The Vertical Steam Still as Applied to Fat Oil Distillation." Another feature of the meeting was the showing of a film of the St. Francis Dam disaster. Several city and county officials who are interested in reconstruction work in the valley ruined by the wall of water, were in attendance.

J. H. SATTERWHITE
President

W. A. SCHLUETER
Vice-President

M. F. WATERS
Vice-President

D. W. MCKAY
Treasurer

REFINERY AND NATURAL GASOLINE PLANT EQUIPMENT BUYERS' GUIDE 1928

THE following pages contain a directory of all equipment used in refineries and natural gasoline plants, together with the name and address of recognized manufacturers and dealers. They contain information that is invaluable to those buying equipment for this branch of the Petroleum Industry.

The BUYERS' GUIDE is compiled annually by the staff of *The* REFINER AND NATURAL GASOLINE MANUFACTURER. No expense is spared in securing complete and authentic information and in arranging the Guide for the convenience of refiners and gasoline plant men. However, it is only through the close co-operation of the many manufacturers and dealers that such a Guide is available.

The value of the Guide to you will be determined by the use you make of it. It is urged that it be kept handy for easy reference whenever plant equipment purchases are to be made.

Directions for Use

Information in the Guide has been arranged according to products, classified under their most common and accepted names and using the main noun as the key index word. However, exceptions have been made to the latter in cases where equipment is more generally known by a combination of words. All concerns listed in the Guide who have advertisements in this issue of *The* REFINER AND NATURAL GASOLINE MANUFACTURER have been designated by prominent type and reference, "See Advertisers' Index." Much valuable information can be secured by following these references.

PLANT EQUIPMENT BUYERS' GUIDE

A

ABSORBERS

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
The Biggs Boiler Works Company, Akron, Ohio.
C. F. Braun & Co., Alhambra, California.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
J. A. Campbell, P. O. Box 669, Long Beach, Calif.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Hope Engineering & Supply Co., Mt. Vernon, Ohio.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Newton Process Mfg. Co., Fullerton, Calif.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.
Wyatt Metal & Boiler Works, Dallas, Texas.

ABSORBERS, Charcoal

Gasoline Recovery Corporation, Charleston, West Virginia.
Wyatt Metal & Boiler Works, Dallas, Texas.

ABSORBERS, Pulsation

The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.
Providence Engineering Corp., Providence, R. I.

ABSORPTION PLANTS

American Radiator Co., 816 S. Michigan Ave., Chicago, Ill.
E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
C. F. Braun & Co., Alhambra, California.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Hope Engineering & Supply Co., Mt. Vernon, Ohio.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

ACETYLENE APPARATUS

Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.
Magnolia Gas Products Co., Houston, Texas.
Modern Engineering Co., 3411 Pine Blvd., St. Louis, Mo.
Oxweld Acetylene Company, 30 East 42nd St., New York, N. Y.
Prest-O-Lite Co., Inc., 30 East 42nd St., New York, N. Y.
Smith Welding Equipment Corporation, 2619-33 Fourth St., S. E., Minneapolis, Minn.
Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill.

ACETYLENE, Dissolved

Prest-O-Lite Co., Inc., 30 East 42nd St., New York, N. Y.

ACETYLENE GAS

Magnolia Gas Products Co., Houston, Texas.
Modern Engineering Co., 3411 Pine Blvd., St. Louis, Mo.
National Oxygen Co., 29 S. LaSalle St., Chicago, Ill.
Prest-O-Lite Co., Inc., 30 East 42nd St., New York, N. Y.

ACCUMULATORS

Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
J. A. Campbell, P. O. Box 669, Long Beach, Calif.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Pittsburgh Pipe & Coil Bending Co., Pittsburgh, Pa.
Wyatt Metal & Boiler Works, Dallas, Texas.

AERATORS

The Connersville Blower Co., Connersville, Ind.

AFTERCOOLERS

American Radiator Co., 816 S. Michigan Ave., Chicago, Ill.
Bessemer Gas Engine Company, Grove City, Pa.
C. F. Braun & Co., Alhambra, California.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Pennsylavnia Pump and Compressor Co., Easton, Pa.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.

AGITATORS

The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Graver Corporation, East Chicago, Ind.
Hammond Iron Works, Warren, Pa.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Mixing Equipment Co., Inc., 229 East 38th St., New York, N. Y.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
The Petroleum Iron Works Co., Sharon, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Sowers Manufacturing Co., 1305 Magra St., Buffalo, N. Y.
Union Engineering Co., Cleveland, Ohio.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.
York Ice Machinery Corporation, 2201 Texas Avenue, Houston, Texas.

AGITATORS, Acid Resisting

The Duriron Company, Inc., Dayton, Ohio.

AGITATORS, Lead Lined

Mixing Equipment Co., Inc., 229 East 38th St., New York, N. Y.

ALARMS, Liquid Level

Electric Tachometer Corporation, 310 N. 11th Street, Philadelphia, Pa.

ALTERNATORS

Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady, New York.
Roth Brothers & Co., 1400 W. Adams St., Chicago, Ill.

ALUMINUM POWER

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.

AMMETERS AND MILLIMETERS

The Bristol Co., Waterbury, Conn.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
General Electric Co., Schenectady, New York.
Houston Armature Works, Houston, Texas.
ILLINOIS TESTING LABORATORIES, INC., 141 W. AUSTIN AVE., CHICAGO, ILL.
All types and makes repaired and tested, 48-hour service if desired.

ANALYZERS, Flue Gas

Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
The Hays Corporation, 1042 East Eighth St., Michigan City, Indiana.
The Refinery Supply Company, Tulsa, Oklahoma.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.

ANALYZERS, Gas

W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
The Hays Corporation, 1042 East Eighth St., Michigan City, Indiana.
The Refinery Supply Company, Tulsa, Oklahoma.

ANCHORS, Pipe

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

ANEOMETERS

Wm. Ainsworth & Sons, 2151 Lawrence St., Denver, Colo.
A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Gray Instrument Co., 64-70, West Johnson St., Germantown, Philadelphia, Pa.
Henry J. Green, 1191 Bedford Ave., Brooklyn, N. Y.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Taylor Instrument Companies, Rochester, N. Y.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

APPARATUS, Aluminum

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.
Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.
MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

APPARATUS, Special Experimental

Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.

ARCHES, Boiler

The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
M. H. Detrick Co., Board of Trade Bldg., Portland, Ore.
Evans & Howard Fire Brick Co., 920 Market St., St. Louis, Mo.
Laclede Christy Clay Prod. Co., 1711 Ambassador Bldg., St. Louis, Mo.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

ARCHES, Combustion Chamber

BERNITZ FURNACE APPLIANCE CO., 80 FEDERAL ST., BOSTON, MASS.
See listing under FURNACE, Walls.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
M. H. Detrick Co., Board of Trade Bldg., Portland, Ore.
Evans & Howard Fire Brick Co., 920 Market St., St. Louis, Mo.
Laclede Christy Clay Prod. Co., 1711 Ambassador Bldg., St. Louis, Mo.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.

ARCHES, Fire Door

American Chimney Corporation, 147 Fourth Ave., New York, N. Y.
DeLaval Steam Turbine Co., Trenton, N. J.
M. H. Detrick Co., Board of Trade Bldg., Portland, Ore.
Evans & Howard Fire Brick Co., 920 Market St., St. Louis, Mo.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

ARCHES, Flat Suspended

BERNITZ FURNACE APPLIANCE CO., 80 FEDERAL ST., BOSTON, MASS.
See listing under FURNACE, Walls.
M. H. Detrick Co., Board of Trade Bldg., Portland, Ore.
Laclede Christy Clay Prod. Co., 1711 Ambassador Bldg., St. Louis, Mo.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.

ARRESTERS, Flame

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

ARRESTERS, Lightning

General Electric Co., Schenectady, New York.
Houston Armature Works, Houston, Texas.

ASBESTOS CLOTHING

Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y.

ASBESTOS PRODUCTS

R. V. Aycock Company, Kansas City, Mo.

ASPHALT

The Philip Carey Mfg. Co., Lockland, Ohio.
Crandall Packing Company, Palmyra, New York.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.
Garlock Packing Co., Palmyra, N. Y.
General Asbestos & Rubber Co., P. O. Box 67, North Charleston, S. C.
Insulating Products Company, 1553 West Madison St., Chicago, Ill.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

ASPHALT

The Philip Carey Mfg. Co., Lockland, Ohio.

B

BABBITT

George B. Allan & Co., Simpson Building, Dallas, Texas.
A. E. Cadman Mfg. Co., 2814 Smallman St., Pittsburgh, Pa.

BABBITING OUTFIT

Barnhart-Davis Co., Warren, Pa
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Hauck Manufacturing Co., 126-134 Tenth St., Brooklyn, N. Y.

BAFFLES, Boiler

BOILER ENGINEERING CO., 931 FEDERAL TRUST BLDG., NEWARK, N. J.
Pioneers in scientific boiler baffling. Originators of the celebrated Turner Baffle, which is now installed in over 3,000,000 h. p. of boilers, saving a half million tons of fuel annually. Also builders of Turner's efficient descendant—the Beco Baffle. Positive expansion joints. Cracking and breaking of walls impossible. No gas leakage. Not monolithic. The most durable baffle wall in the world.
Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh, Pa.
King Refractories Co., Inc., 1715 Niagara St., Buffalo, N. Y.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.
Henry Vogt Machine Co., Louisville, Ky.

BAFFLES, Refractory

Boiler Engineering Co., 931 Federal Trust Bldg., Newark, N. J.
Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Evans & Howard Fire Brick Co., 920 Market St., St. Louis, Mo.
Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh, Pa.
King Refractories Co., Inc., 1715 Niagara St., Buffalo, N. Y.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.

BAFFLE WALLS

Boiler Engineering Co., 931 Federal Trust Bldg., Newark, N. J.
Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
King Refractories Co., Inc., 1715 Niagara St., Buffalo, N. Y.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.

BALANCES, Analytical

Wm. Ainsworth & Sons, 2151 Lawrence St., Denver, Colo.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Palo Company, 153 West 23rd St., New York, N. Y.

BALANCES, Spring

W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Griebel Instrument Co., Carbondale, Pa.

BAROMETERS

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Henry J. Green, 1191 Bedford Ave., Brooklyn, N. Y.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.
Kolesch & Co., 138 Fulton St., New York, N. Y.
Palo Company, 153 West 23rd St., New York, N. Y.
Taylor Instrument Companies, Rochester, N. Y.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

BARRELS

Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Pekin Cooperage Co., Port Arthur, Texas.
The Petroleum Iron Works Co., Sharon, Pa.

BARS, Reinforcing Concrete Work

Michelmann Steel Construction Co., Cor. of Second & Hampshire Sts., Quincy, Ill.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.

BEAMS, Steel

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Michelmann Steel Construction Co., Cor. of Second & Hampshire Sts., Quincy, Ill.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
Wyatt Metal & Boiler Works, Dallas, Texas.

BEAMS, Tube Still

The Calorizing Co., Pittsburgh, Pa.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

BEARINGS

Houston Armature Works, Houston, Texas.

BEARINGS, Ball

Houston Armature Works, Houston, Texas.
Norma-Hoffmann Bearings Corporation, Stamford, Conn.

BEARINGS, Roller

Norma-Hoffmann Bearings Corporation, Stamford, Conn.

BEARINGS, Self-Oiling, Adjustable

THE HILL CLUTCH MACHINERY & FOUNDRY CO., CLEVELAND, OHIO.
Specify "Cleveland Type" Oil Film Bearing. Flood lubrication floats the shaft free from metallic contact. Highest efficiency and endurance. Furnished in all styles of rigid and ball and socket mountings adjustable four ways.

BEARINGS, Thrust

Norma-Hoffmann Bearings Corporation, Stamford, Conn.

BELT DRESSING

Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
Cling-Surface Company, 1032-1048 Niagara Street, Buffalo, N. Y.
Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.

BELT LACING, Steel

The Bristol Co., Waterbury, Conn.

BELT TIGHTENERS

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Union Engineering Co., Cleveland, Ohio.

BELTING

E. F. Houghton & Company, Philadelphia, Pa.

BELTING, Balata

Jarecki Manufacturing Co., St. Louis, Mo.

BELTING, Canvas

Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.

BELTING, Conveyor

New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.

BELTING, Elevator

New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.

BELTING, Leather

Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.

BELTING, Leather, Flat, Round, V-Belt

E. F. Houghton & Company, Philadelphia, Pa.

BELTING, Rubber

Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.
New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.
Voorhees Rubber Mfg. Co., 105 Hudson St., New York, N. Y.

BELTING, Transmission

Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
Crandall Packing Company, Palmyra, New York.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.
New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.

BELTING, Waterproof

Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.
New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.

BELTS, Safety

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

BINS, Ash

Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Hammond Iron Works, Warren, Pa.
Union Engineering Co., Cleveland, Ohio.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

BITUMEN GUNS

Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.

BLOCKS, Asbestos

R. V. Aycock Company, Kansas City, Mo.
The Philip Carey Mfg. Co., Lockland, Ohio.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.

BLOCKS, Insulating

R. V. Aycock Company, Kansas City, Mo.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.

BLOCKS, Pillow

Bessemer Gas Engine Company, Grove City, Pa.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

BLOWCASES

Hammond Iron Works, Warren, Pa.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

BLOWCASES, Automatic

Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.

BLOWERS, Electric

The Connersville Blower Co., Connersville, Ind.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
General Electric Co., Schenectady, New York.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.

Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
The Spencer Turbine Co., Hartford, Conn.

BLOWERS, Exhaust

De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, New York.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
The Spencer Turbine Co., Hartford, Conn.

BLOWERS, Flue Gas

Coppus Engineering Corporation, Worcester, Mass.
B. P. LIENTZ & CO., 3409 EAST 18 ST., KANSAS CITY, MO. The Lientz Recirculating System.

BLOWERS, Forge

The Connersville Blower Co., Connersville, Ind.
The Spencer Turbine Co., Hartford, Conn.

BLOWERS, Multi-Stage

De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady. New York.
Maxon Premix Burner Co., Muncie, Ind.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
The Spencer Turbine Co., Hartford, Conn.

BLOWERS, Oil Burner

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Griebel Instrument Co., Carbondale, Pa.
North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
The Spencer Turbine Co., Hartford, Conn.
Wilbraham Green Blowers Co., Pottstown, Pa.

BLOWERS, Pressure

Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.
De Laval Steam Turbine Co., Trenton, N. J.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Maxon Premix Burner Co., Muncie, Ind.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
The Spencer Turbine Co., Hartford, Conn.
Wilbraham Green Blowers Co., Pottstown, Pa.

BLOWERS, Rotary Gas

Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.

BLOWERS, Rotary, Pressure

The Connersville Blower Co., Connersville, Ind.
Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Elliott Co., Jeannette, Pa.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Palo Company, 153 West 23rd St., New York, N. Y.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
The Spencer Turbine Co., Hartford, Conn.
Wilbraham Green Blowers Co., Pottstown, Pa.

BLOWERS, Soot

George B. Allan & Co., Simpson Building, Dallas, Texas.
DIAMOND POWER SPECIALTY CORPORATION, DETROIT, MICH.

Diamond Soot Blowers are standard equipment on the largest modern boilers, cracking stills, pipe stills and oil preheaters. They cut fuel consumption from 4 to 8 per cent. and increase through-put or capacity from 10 to 20 per cent. under average conditions.

General Specialty Co., 61-69 Carroll St., Buffalo, N. Y.
Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.
Reiter Company, 259 North St., Elgin, Ill.
THE VULCAN SOOT CLEANER CO., WEBSTER BLDG., DUBOIS, PA.

Soot Cleaners for all types of boilers, superheaters, economizers, oil heating apparatus, etc.

BLOWERS, Steam Jet

Elliott Co., Jeannette, Pa.

BLOWERS, Turbine

De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady, New York.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
The Spencer Turbine Co., Hartford, Conn.

BLOWERS, Ventilating

Coppus Engineering Corporation, Worcester, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.

BLOWPIPES, Welding and Cutting

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Modern Engineering Co., 3411 Pine Blvd., St. Louis, Mo.
Smith Welding Equipment Corporation, 2619-33 Fourth St., S. E., Minneapolis, Minn.
Henry Vogt Machine Co., Louisville, Ky.

BLUE PRINTING MACHINES

SHAW BLUE PRINT MACHINE CO., INC., 9-11-13 CAMPBELL ST., NEWARK, N. J.

Manufacturers of Shaw Model "A" Vertical Continuous Electric Printer, Simplex—Horizontal Continuous Electric Printer, Model W Wringer, Model D Wringer and Dryer.

BOILER FEED UNITS

Byron Jackson Pump Co., Berkeley, Calif.
De Laval Steam Turbine Co., Trenton, N. J.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

BOILER, Scale Treatment

CROWN MANUFACTURING CO., 7016 EUCLID AVE., CLEVELAND, OHIO.

Manufacturers of IMPERIAL BOILER CLEANSER—the nearest to a perfect compound made and sold. Guaranteed—no cure, no pay. Absolutely best and cheapest.

Graver Corporation, East Chicago, Ind.
HAWK-EYE COMPOUND CO., BLUE ISLAND, SUBURB OF CHICAGO, ILL.

For the prevention and removal of scale, pitting and priming in steam boilers. Scientifically prepared. Have successfully handled most trying conditions for 30 years.

Michelmann Steel Construction Co., Cor. of Second & Hampshire Sts., Quincy, Ill.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.
Ward Chemical Co., Tulsa, Okla.

BOILER SETTINGS

Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.

BOILERS, Fire Box

The Bigelow Co., 76 River St., New Haven, Conn.
Coatesville Boiler Works, Coatesville, Pa.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Godfrey, Keeler Co., 70 Warren St., New York, N. Y.
Kewanee Boiler Corporation, Kewanee, Ill.
The James Leffel & Co., Springfield, Ohio.
Michelmann Steel Construction Co., Cor. of Second & Hampshire Sts., Quincy, Ill.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Titusville Iron Works Co., Titusville, Pa.
Henry Vogt Machine Co., Louisville, Ky.

BOILERS, High Pressure

The Bigelow Co., 76 River St., New Haven, Conn.
Coatesville Boiler Works, Coatesville, Pa.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Erie City Iron Works, Erie City, Pa.
Godfrey, Keeler Co., 70 Warren St., New York, N. Y.
Kewanee Boiler Corporation, Kewanee, Ill.
The James Leffel & Co., Springfield, Ohio.
Michelmann Steel Construction Co., Cor. of Second & Hampshire Sts., Quincy, Ill.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Seamless Steel Equipment Corp., 39 Broadway, New York, N. Y.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Titusville Iron Works Co., Titusville, Pa.
Henry Vogt Machine Co., Louisville, Ky.

BOILERS, Low Pressure

The Bigelow Co., 76 River St., New Haven, Conn.
Coatesville Boiler Works, Coatesville, Pa.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Gorton Heating Corporation, 96 Liberty Street, New York, N. Y.
Kewanee Boiler Corporation, Kewanee, Ill.
Titusville Iron Works Co., Titusville, Pa.
Henry Vogt Machine Co., Louisville, Ky.

BOILERS, Tubular Horizontal

American Chimney Corporation, 147 Fourth Ave., New York, N. Y.
The Bigelow Co., 76 River St., New Haven, Conn.
Coatesville Boiler Works, Coatesville, Pa.
Erie City Iron Works, Erie City, Pa.
Godfrey, Keeler Co., 70 Warren St., New York, N. Y.
Kewanee Boiler Corporation, Kewanee, Ill.
The James Leffel & Co., Springfield, Ohio.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Titusville Iron Works Co., Titusville, Pa.
Henry Vogt Machine Co., Louisville, Ky

BOILERS, Water Tube

Badenhausen Corporation, 900 Victory, Bldg., Philadelphia, Pa.
The Bigelow Co., 76 River St., New Haven, Conn.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Henry Vogt Machine Co., Louisville, Ky.

BOLTS

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Erie City Iron Works, Erie City, Pa.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

BOLTS AND NUTS

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.

BOLTS AND NUTS, Acid Resisting

The Duriron Company, Inc., Dayton, Ohio.

BOLTS AND NUTS, Monel Metal

Equitable Equipment Company Inc., 410 Camp St., New Orleans, La.

BOLTS, Brass

Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.
Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.

BOLTS, Boiler

Henry Vogt Machine Co., Louisville, Ky.

BOLTS, Tank

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

BOMBS AND GAUGES

W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The R. S. Manufacturing Co., 3404-06 Main St., Dallas, Texas.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.

BOOSTERS, Gas

Bessemer Gas Engine Company, Grove City, Pa.
The Connersville Blower Co., Connersville, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Elliott Co., Jeannette, Pa.
Hammond Iron Works, Warren, Pa.
Hope Engineering & Supply Co., Mt. Vernon, Ohio.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.
Wilbraham Green Blowers Co., Pottstown, Pa.

BOOTS, Rubber

M. L. Snyder & Son, 116 No. 3rd St., Philadelphia, Pa.

BORERS, Bung

Weimar Engineering Works, Jasper & Westmoreland Sts., Philadelphia, Pa.

BOTTLES, Oil Sample

W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.

The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Whitall-Tatum Co., 410-416 Race St., Philadelphia, Pa.

BOXES, Condensing

Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.

Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.

Coatesville Boiler Works, Coatesville, Pa.

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Graver Corporation, East Chicago, Ind.

Hammond Iron Works, Warren, Pa.

The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.

Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

The Petroleum Iron Works Co., Sharon, Pa.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

Wyatt Metal & Boiler Works, Dallas, Texas.

BOXES, Cooling

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.

Graver Corporation, East Chicago, Ind.

The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

The Petroleum Iron Works Co., Sharon, Pa.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

Wyatt Metal & Boiler Works, Dallas, Texas.

BOXES, Junction

The Ohio Steel Foundry Co., Springfield, Ohio.

BOXES, Knockout

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

Wyatt Metal & Boiler Works, Dallas, Texas.

BOXES, Look

Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

The R. S. Manufacturing Co., 3404-06 Main St., Dallas, Texas.

Joseph Reid Gas Engine Co., Oil City, Pa.

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

BRAKE LINING

Garlock Packing Co., Palmyra, N. Y.

General Asbestos & Rubber Co., P. O. Box 67, North Charleston, S. C.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

Keasbey & Mattison Co., Ambler, Pa.

Joseph Reid Gas Engine Co., Oil City, Pa.

BRASS GOODS

Jarecki Manufacturing Co., St. Louis, Mo.

Mueller Co., Decatur, Ill.

BRAZING APPARATUS

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

Hauck Manufacturing Co., 126-134 Tenth St., Brooklyn, N. Y.

Oxweld Acetylene Company, 30 East 42nd St., New York, N. Y.

Prest-O-Lite Co., Inc., New York, N. Y.

Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill.

BREATHING APPARATUS, McCaa Oxygen

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

BREECHINGS, Boiler

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Connery & Co., Inc., Second & Luzerne Sts., Philadelphia, Pa.

Coatesville Boiler Works, Coatesville, Pa.

Graver Corporation, East Chicago, Ind.

Hammond Iron Works, Warren, Pa.

The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

Titusville Iron Works Co., Titusville, Pa.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

Wyatt Metal & Boiler Works, Dallas, Texas.

BREECHINGS, Smoke

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.

Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Connery & Co., Inc., Second & Luzerne Sts., Philadelphia, Pa.

Graver Corporation, East Chicago, Ind.

Hammond Iron Works, Warren, Pa.

Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

Titusville Iron Works Co., Titusville, Pa.

Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

Wyatt Metal & Boiler Works, Dallas, Texas.

BRICK, Chemical

Acme Brick Co., Fort Worth, Tex.

The U. S. Stoneware Co., 50 Church St., New York, N. Y.

BRICK, Common

Acme Brick Co., Fort Worth, Tex.

Elgin-Butler Brick Co., Austin, Texas.

BRICK, Face

Elgin-Butler Brick Co., Austin, Texas.

BRICK, Fire

Acme Brick Co., Fort Worth, Tex.

American Chimney Corporation, 147 Fourth Ave., New York, N. Y.

Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.

Bernitz Furnace Appliance Co., 80 Federal St., Boston, Mass.

Crescent Refractories Co., Curwensville, Pa.

De Laval Steam Turbine Co., Trenton, N. J.

The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

Elgin-Butler Brick Co., Austin, Texas.

Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh, Pa.

SOUTHERN REFRACTORIES CO., FT. PAYNE, ALA.
Ladd Bauxite Jointless Refractories are plastic, last twice as long, sold for less, rammed in by any labor, record time, shipped dry, don't pay for water.—Southern Refractories Co.

BRICK, Insulating

R. V. Aycock Company, Kansas City, Mo.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

BRICK, Oil Heating Furnace

SOUTHERN REFRACTORIES CO., FORT PAYNE, ALABAMA.
Ladd Bauxite Jointless Refractories are plastic, last twice as long, sold for less, rammed in by any labor, record time, shipped dry, don't pay for water; satisfaction guaranteed. Southern Refractories Co., Fort Payne, Ala.

BUCKETS, Clamshell

Blaw-Knox Co., Pittsburgh, Pa.

BUILDINGS, Industrial

Blaw-Knox Co., Pittsburgh, Pa.

Braden Steel Corporation, 3 No. Madison, Tulsa, Okla.

Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Industrial Construction Co., 305 Central National Bank Bldg., Tulsa, Okla.

Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.

Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.

Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

Wyatt Metal & Boiler Works, Dallas, Texas.

BUILDINGS, Metal

Blaw-Knox Co., Pittsburgh, Pa.

Braden Steel Corporation, 3 No. Madison, Tulsa, Okla.

Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Industrial Construction Co., 305 Central National Bank Bldg., Tulsa, Okla.

Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.

Wyatt Metal & Boiler Works, Dallas, Texas.

BUILDINGS, Steel

Blaw-Knox Co., Pittsburgh, Pa.

Braden Steel Corporation, 3 No. Madison, Tulsa, Okla.

Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Industrial Construction Co., 305 Central National Bank Bldg., Tulsa, Okla.

Mosher Steel and Machinery Co., Box 238, Dallas, Texas.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

Truscon Steel Co., Youngstown, Ohio.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

Wyatt Metal & Boiler Works, Dallas, Texas.

BUILDINGS, Steel, Sectional

BRADEN STEEL CORPORATION, 3 N. MADISON, TULSA, OKLAHOMA.
Being constructed in standard units or sections, these buildings can be adapted to any purpose. All rivets are driven hot. The copper bearing galvanized corrugated sheets are fastened to the steel sections by means of aluminum alloy rust proof rivets. The sliding doors are unusually well made and tight fitting. The best of workmanship is required.

BULBS, Rectifiers

General Electric Co., Schenectady, New York.

BULLETIN BOARDS

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

BURNERS, Boiler

W. N. Best Corporation, 101 West 31st St., New York, N. Y.

N. C. Davison Gas Burner & Welding Co., 2939 Smallman St., Pittsburgh, Pa.

The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.

Duquesne Burner Service Co., P. O. Box 1753, Pittsburgh, Pa.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

Gas Combustion Company, P. O. Box 1753, Pittsburgh, Pa.

Maxon Premix Burner Co., Muncie, Ind.

Lee B. Mettler Co., 830 San Fernando Bldg., Los Angeles, California.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.

The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.

BURNERS, Electric, Oil

W. N. Best Corporation, 101 West 31st St., New York, N. Y.

National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.

BURNERS, Furnace

W. N. Best Corporation, 101 West 31st St., New York, N. Y.

N. C. Davison Gas Burner & Welding Co., 2939 Smallman St., Pittsburgh, Pa.

The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.

Duquesne Burner Service Co., P. O. Box 1753, Pittsburgh, Pa.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

Hauck Manufacturing Co., 126-134 Tenth St., Brooklyn, N. Y.

B. P. Lientz & Co., 3409 East 18th St., Kansas City, Mo.

The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.

Maxon Premix Burner Co., Muncie, Ind.

May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
Lee B. Mettler Co., 830 San Fernando Bldg., Los Angeles, California.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.

BURNERS, Gas

W. N. Best Corporation, 101 West 31st St., New York, N. Y.

N. C. DAVISON GAS BURNER & WELDING CO., 2938 SMALLMAN ST., PITTSBURGH, PA.

The Davison H. P. Mist Oil or the H. P. Gas Burner, using low pressure fan air, will reduce fuel costs, give greater output and save time, when used under stills, boilers or industrial furnaces.

The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Gas Combustion Company, P. O. Box 1753, Pittsburgh, Pa.
Griebel Instrument Co., Carbondale, Pa.
B. P. Lientz & Co., 3409 East 18th St., Kansas City, Mo.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Maxon Premix Burner Co., Muncie, Ind.

LEE B. METTLER CO., 830 SAN FERNANDO BLDG., LOS ANGELES, CALIF.

Mettler Entrained Combustion Gas Burners are built on the Multi-Unit Multi-Jet principle, which insures a very thorough mixing of air and gas and results in complete combustion close to the end of the burner with a minimum amount of excess air and maximum furnace temperature.

Mettler Burners will produce the best results obtainable from combustion of gas.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.
Volz Engineering Corporation, 3732-3734 East 7th St., Long Beach, Calif.

BURNERS, Gas and Oil Combined

W. N. Best Corporation, 101 West 31st St., New York, N. Y.
Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
N. C. Davison Gas Burner & Welding Co., 2939 Smallman St., Pittsburgh, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Gas Combustion Company, P. O. Box 1753, Pittsburgh, Pa.
B. P. Lientz & Co., 3409 East 18th St., Kansas City, Mo.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Maxon Premix Burner Co., Muncie, Ind.
Lee B. Mettler Co., 830 San Fernando Bldg., Los Angeles, California.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.
Volz Engineering Corporation, 3732-3734 East 7th St., Long Beach, Calif.

BURNERS, Laboratory

Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
N. C. Davison Gas Burner & Welding Co., 2939 Smallman St., Pittsburgh, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.
Palo Company, 153 West 23rd St., New York, N. Y.

BURNERS, Low Pressure

W. N. Best Corporation, 101 West 31st St., New York, N. Y.
N. C. Davison Gas Burner & Welding Co., 2939 Smallman St., Pittsburgh, Pa.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Maxon Premix Burner Co., Muncie, Ind.
Lee B. Mettler Co., 830 San Fernando Bldg., Los Angeles, California.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.

BURNERS, Oil

W. N. Best Corporation, 101 West 31st St., New York, N. Y.
N. C. Davison Gas Burner & Welding Co., 2939 Smallman St., Pittsburgh, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.

HAUCK MANUFACTURING CO., 127 TENTH ST., BROOKLYN, N. Y.

Venturi High Pressure (steam or compressed air); Venturi Low Pressure (8 oz. to 2 lbs.)

B. P. Lientz & Co., 3409 East 18th St., Kansas City, Mo.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.
Maxon Premix Burner Co., Muncie, Ind.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.
The North American Mfg. Co., 2920 E. 75th St., Cleveland, Ohio.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.
Volz Engineering Corporation, 3732-3734 East 7th St., Long Beach, Calif.

BURNERS, Oil High Pressure

W. N. Best Corporation, 101 West 31st St., New York, N. Y.
N. C. Davison Gas Burner & Welding Co., 2939 Smallman St., Pittsburgh, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Maxon Premix Burner Co., Muncie, Ind.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.

BURNERS, Oil, low pressure

Hauck Manufacturing Co., 126-134 Tenth St., Brooklyn, N. Y.

BURNERS, Still

W. N. Best Corporation, 101 West 31st St., New York, N. Y.
N. C. Davison Gas Burner & Welding Co., 2939 Smallman St., Pittsburgh, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Duquesne Burner Service Co., P. O. Box 1753, Pittsburgh, Pa.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Gas Combustion Company, P. O. Box 1753, Pittsburgh, Pa.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Maxon Premix Burner Co., Muncie, Ind.
Lee B. Mettler Co., 830 San Fernando Bldg., Los Angeles, California.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.

C

CABINETS

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

CABINETS, First Aid

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

CABINETS, Steel

Frank S. Betz Co., Hammond, Ind.

CALORIMETERS

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Metric Metal Works, Erie, Pa.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

CALORIMETERS, Gas

Precision Scientific Co., 1736-54 N. Springfield Ave., Chicago, Ill.

CANS

Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Geuder, Paeschke & Frey Co., St. Paul Ave. and 15th St., Milwaukee, Wis.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Moncrief-Lenoir Mfg. Co., Houston, Texas.

CANS, Oil

Sexton Can Co., Inc., 31 Cross St., Everett, Mass.

CAPS, Bubble

American Radiator Co., 816 S. Michigan Ave., Chicago, Ill.
E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

CAPS, Outlet

Carnes Equipment Company, Box 595, Sand Springs, Oklahoma.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

CASTINGS, Brass

A. W. Cadman Manufacturing Company, 2816 Smallman St., Pittsburgh, Pa.
Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

CASTINGS, Bronze

A. W. Cadman Manufacturing Company, 2816 Smallman St., Pittsburgh, Pa.
Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.
Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.
Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

CASTINGS, Acid Resisting Bronze

A. W. Cadman Manufacturing Company, 2816 Smallman St., Pittsburgh, Pa.

CASTINGS, Bubble Deck

M. W. Kellogg Co., 7 Day St., New York, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

CASTINGS, Bubble Tower

The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
The Ohio Steel Foundry Co., Springfield, Ohio.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

CASTINGS, Cast Iron

Barnhart-Davis Co., Warren, Pa.
Coatesville Boiler Works, Coatesville, Pa.
Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

CASTINGS, Copper

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

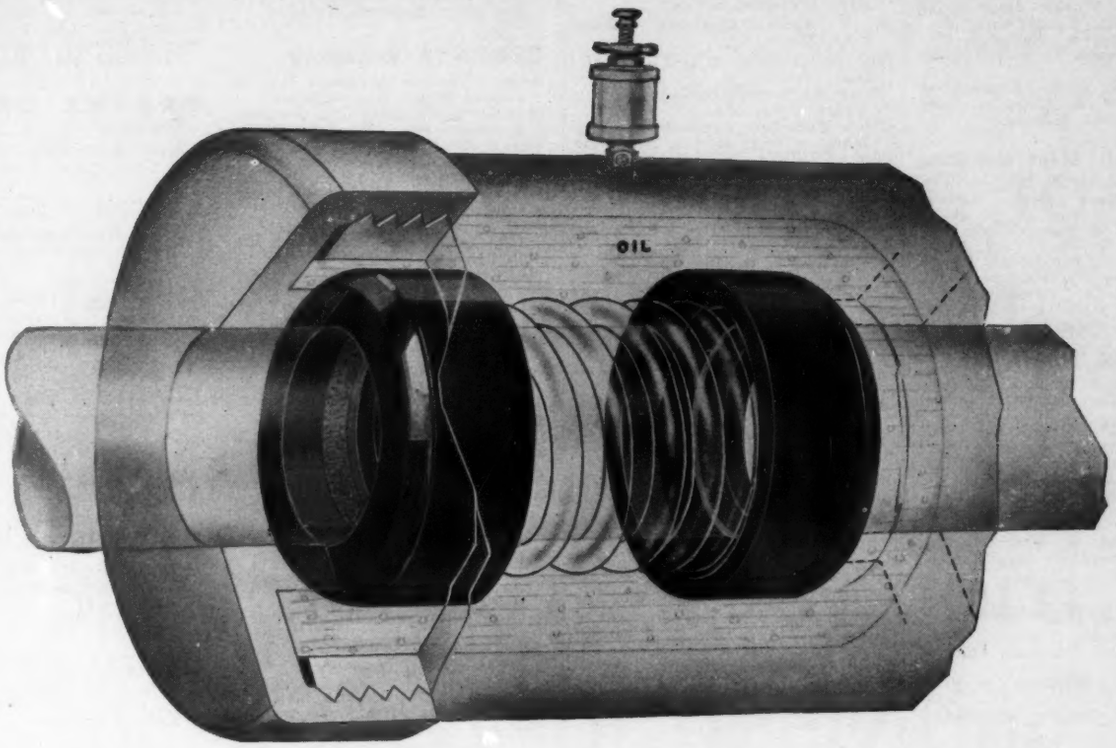
CASTINGS, Corrosion Resisting

Cyclops Steel Co., Titusville, Pa.

CASTINGS, Grey Iron

Buffalo Foundry & Machine Co., 1569 Fillmore Ave., Buffalo, N. Y.

It stands the gaff of the refinery



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Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

CASTINGS, Heat Resisting

Buffalo Foundry & Machine Co., 1569 Fillmore Ave., Buffalo, N. Y.
The Babcock & Wilcox Tube Co., 85 Liberty St., New York, N. Y.
Blaw-Knox Co., Pittsburgh, Pa.
The Calorizing Co., Pittsburgh, Pa.
Cyclops Steel Co., Titusville, Pa.
The Ohio Steel Foundry Co., Springfield, Ohio.

CASTINGS, Iron

Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Rosedale Foundry & Machine Co., Columbus and Preble Aves., N. S., Pittsburgh, Pa.
Henry Vogt Machine Co., Louisville, Ky.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

CASTINGS, Mall-Iron

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.
Malleable Iron Fittings Co., Banford, Conn.
Reading Steel Castings Co., Bridgeport, Conn.

CASTINGS, Monel Metal

Equitable Equipment Company, Inc., 410 Camp St., New Orleans, La.

CASTINGS, Semi-Steel

Barnhart-Davis Co., Warren, Pa
Coatesville Boiler Works, Coatesville, Pa.
Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

CASTINGS, Steel

The Falk Corporation, Milwaukee, Wisconsin.
Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.
Hughes Tool Co., 300 Hughes St., Houston, Texas.
Malleable Iron Fittings Co., Banford, Conn.
The Ohio Steel Foundry Co., Springfield, Ohio.
Oklahoma Steel Castings Co., North Peoria Road, Tulsa, Okla.
Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.
Reading Steel Castings Co., Bridgeport, Conn.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

CASTINGS, Tank Car

Carnes Equipment Company, Box 595, Sand Springs, Oklahoma.
The Ohio Steel Foundry Co., Springfield, Ohio.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Oklahoma Steel Castings Co., North Peoria Road, Tulsa, Okla.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

CEMENT, Acid Proof

Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.
Ward Chemical Co., Tulsa, Okla.

CEMENT, Asbestos

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
R. V. Aycock Company, Kansas City, Mo.
The Philip Carey Mfg. Co., Lockland, Ohio.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

CEMENT, Boiler Setting

Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

CEMENT, Fire Brick

R. V. Aycock Company, Kansas City, Mo.
Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
Crescent Refractories Co., Curwensville, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh, Pa.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.

CEMENT, High Temp.

R. V. Aycock Company, Kansas City, Mo.
Banner Rock Products Co., Alexandria, Indiana.
Bernitz Furnace Appliance Co., 80 Federal Street, Boston, Mass.
Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
The Philip Carey Mfg. Co., Lockland, Ohio.
Crescent Refractories Co., Curwensville, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.
Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh, Pa.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

CEMENT, Leather Belting

Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.

CEMENT, Magnesia

The Philip Carey Mfg. Co., Lockland, Ohio.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

CEMENTS, Refractory

Bernitz Furnace Appliance Co., 80 Federal Street, Boston, Mass.
Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
The Philip Carey Mfg. Co., Lockland, Ohio.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Laclede Christy Clay Prod. Co., 1711 Ambassador Bldg., St. Louis, Mo.
Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Southern Refractories Co., Fort Payne, Alabama.
Ladd Bauxite 50-50 at Fire Clay price. Southern Refractories Co., Fort Payne, Ala.

CEMENT, Rock Wool

Banner Rock Products Co., Alexandria, Indiana.

CEMENT, Roofing

The Philip Carey Mfg. Co., Lockland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.
Ward Chemical Co., Tulsa, Okla.

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BANNER ROCK PRODUCTS CO., ALEXANDRIA, IND.
The BANROC H. T. W. is a high temperature waterproofing cement for finishing outside refinery eqiupment. It is waterproof and flashproof.

CEMENT, Webers No. 48, Insulating

Insulating Products Company, 1553 West Madison St., Chicago, Ill.
Efficient, durable and economical. Is shipped in dry form in 50-pound burlap bags and needs only to be mixed with water to make ready for easy application. An efficient insulation in the presence of temperatures up to 2000 degrees F.

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W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

CHAINS

U. S. Chain & Forging Co., Union Trust Bldg., Pittsburgh, Pa.

CHARCOAL, Activated

The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
The Refinery Supply Company, Tulsa, Oklahoma.

CHARCOAL, Gasoline Plant

Gasoline Recovery Corporation, Charleston, West Virginia.
Ward Chemical Co., Tulsa, Okla.

CHIMNEYS

American Chimney Corporation, 147 Fourth Ave., New York, N. Y.

CHISEL BLANKS

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Cyclops Steel Co., Titusville, Pa.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

CHROME ORE, Adachrome

Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.

CHUCKS

Union Manufacturing Company New Britain, Conn.

CHUCKS, Nipple

The Armstrong Mfg. Co., 27 Cleveland Place, near Spring St., New York, N. Y.

CLAMPS, Collar Leak

PERFECTION CLAMP M'FRS., 125 WILLIAM ST., LOCKLAND, OHIO.
The Perfection Leak-Closing Clamp is guaranteed to stop all leaks on steam, air, gas, water, vacuum and ammonia piping which leak at threads or peaned joints next to any fitting.
M. B. Skinner Co., 562 Washington Blvd., Chicago, Ill.

CLAMPS, Pipe

Mueller Co., Decatur, Ill.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
The Ohio Steel Foundry Co., Springfield, Ohio.

CLAMPS, Pipe Joint

Mueller Co., Decatur, Ill.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.
M. B. Skinner Co., 562 Washington Blvd., Chicago, Ill.

CLAMPS, Pipe Line

M. B. Skinner Co., 562 Washington Blvd., Chicago, Ill.

CLAMPS, Weld Leak

M. B. Skinner Co., 562 Washington Blvd., Chicago, Ill.

CLARIFIERS, Gasoline

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

CLAY, Fire

Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
Crescent Refractories Co., Curwensville, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Elgin-Butler Brick Co., Austin, Texas.
Evans & Howard Fire Brick Co., 920 Market St., St. Louis, Mo.
Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh, Pa.
Laclede Christy Clay Prod. Co. 1711 Ambassador Bldg., St. Louis, Mo.

CLAYS, Filtering

Filtrol Company, 506 A. G. Bartlett Bldg., Los Angeles, Calif.
Laclede Christy Clay Prod. Co. 1711 Ambassador Bldg., St Louis, Mo.

CLEANERS, Air

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

CLEANERS, Boiler Tube

Diamond Power Specialty Corporation, Detroit, Mich.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

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Chicago, Illinois

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Liberty Manufacturing Co., Jeannette, Pa.

THE WILLIAM B. PIERCE COMPANY, 45 NORTH DIVISION ST., BUFFALO, N. Y. Manufacturers of the DEAN BOILER TUBE CLEANER, a mechanical tool for thoroughly dislodging scale from the water side of tubes of either return tubular or water tube boilers. Also dislodges soot deposit from fire side of tubes. Principle—vibration. Motive power—compressed air or steam. Manufactured for tubes 1½" to 7" inside diameter.

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Rosedale Foundry & Machine Co., Columbus and Preble Aves., N. S., Pittsburgh, Pa.

The Roto Company, Sussex Ave. and Neward St., Newark, N. J.

Ward Chemical Co., Tulsa, Okla.

CLEANERS, Flue

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

General Specialty Co., 61-69 Carroll St., Buffalo, N. Y.

Lagonda Manufacturing Co., Springfield, Ohio.

Liberty Manufacturing Co., Jeannette, Pa.

The Roto Company, Sussex Ave. and Neward St., Newark, N. J.

CLEANERS, Still

HUGHES TOOL CO., 300 HUGHES ST., HOUSTON, TEXAS.

The Hughes Soaking Drum Cleaner was developed to remove coke deposits that collect in soaking drums or reaction chambers, more particularly in connection with the Tube and Tank and the Dubbs processes. It consists of a hydraulic cylinder sunk in the ground under the center of each drum and containing a rota-table drill stem. A steam driven portable rotary for driving the drill stem is provided and can be moved from one unit to another.

CLEANERS, Metal

Oakite Products, Inc., 22 Thames St., New York, N. Y.

CLEANERS, Pipe Line

Oakite Products, Inc., 22 Thames St., New York, N. Y.

CLEANERS, Still Tube

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

Lagonda Manufacturing Co., Springfield, Ohio.

Liberty Manufacturing Co., Jeannette, Pa.

ROTO COMPANY, SUSSEX AVE. & NEWARD ST., NEWARK, N. J.

Roto Tube Cleaners for tube and cracking stills are specially designed to develop great power and speed for the quick and thorough cleaning of tubes as small as three inches inside diameter.

Ward Chemical Co., Tulsa, Okla.

CLEANERS, Tank

Oakite Products, Inc., 22 Thames St., New York, N. Y.

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

CLEANERS, Tank Car

Oakite Products, Inc., 22 Thames St., New York, N. Y.

CLOCKS, Engine Room

The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

CLOCKS, Time

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.

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Chicago Watchman's Clock Co., 1526 S. Wabash Ave., Chicago, Ill.

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Kolesch & Co., 138 Fulton St., New York, N. Y.

U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.

CLOTH, Filter, Monel Metal

Newark Wire Cloth Company, 364-378 Verona Ave., Newark, N. J.

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A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.

Kolesch & Co., 138 Fulton St., New York, N. Y.

U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.

CLOTH, Wire

The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.

Newark Wire Cloth Company, 364-378 Verona Ave., Newark, N. J.

CLOTH, Wire, Monel Metal

Equitable Equipment Company, Inc., 410 Camp St., New Orleans, La.

CLOTHING, Oiled

M. L. Snyder & Son, 116 No. 3rd St., Philadelphia, Pa.

CLOTHING, Safety

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

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General Asbestos & Rubber Co., P. O. Box 67, North Charleston, S. C.

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Specify "Smith Type" Hill Clutches. Sizes 9 to 1100 HP. Rugged construction, accessible, simple adjustment and dependable.

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Union Engineering Co., Cleveland, Ohio.

CLUTCHES, Reverse

Bessemer Gas Engine Company, Grove City, Pa.

Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.

Titusville Iron Works Co., Titusville, Pa.

CLUTCHES, One-Way and Reverse

Joseph Reid Gas Engine Co., Oil City, Pa.

Metal Coatings Co. of America, 495 N. Third St., Philadelphia, Pa.

COATINGS, Metal

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

Metal Coatings Co. of America, 495 N. Third St., Philadelphia, Pa.

Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.

Struthers-Wells Co., Warren, Pa.

COCKS

Homestead Valve Mfg. Co., Inc., Homestead, Pa.

Jarecki Manufacturing Co., St. Louis, Mo.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.

Reading Steel Castings Co., Bridgeport, Conn.

COCKS, Acid-proof Stoneware

The U. S. Stoneware Co., 50 Church St., New York, N. Y.

COCKS, Air

Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.

Homestead Valve Mfg. Co., Inc., Homestead, Pa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.

Mueller Co., Decatur, Ill.

Reading Steel Castings Co., Bridgeport, Conn.

COCKS, Asbestos Packed

Judson Governor Co., Rochester, N. Y.

COCKS, Blow-off

Judson Governor Co., Rochester, N. Y.

COCKS, Drain

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

Mueller Co., Decatur, Ill.

COCKS, Gas

Homestead Valve Mfg. Co., Inc., Homestead, Pa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.

Mueller Co., Decatur, Ill.

COCKS, Gauge

Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

Northern Valve Co., 806 Union St., Utica, N. Y.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

The Wm. Powell Co., Cincinnati, Ohio.

Henry Vogt Machine Co., Louisville, Ky.

The Williams Gauge Co., 1620 Pennsylvania Ave., N. S., Pittsburgh, Pa.

COCKS, Gauge Water

Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.

COCKS, Gland Packed

H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.

Homestead Valve Mfg. Co., Inc., Homestead, Pa.

Judson Governor Co., Rochester, N. Y.

Reading Steel Castings Co., Bridgeport, Conn.

COCKS, Non-Sticking, Acid Resisting

The Duriron Company, Inc., Dayton, Ohio.

COCKS, Oil

Homestead Valve Mfg. Co., Inc., Homestead, Pa.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.

Mueller Co., Decatur, Ill.

National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.

The Wm. Powell Co., Cincinnati, Ohio.

COCKS, Oil Packed

Judson Governor Co., Rochester, N. Y.

COCKS, Plug

Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.

H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.

Homestead Valve Mfg. Co., Inc., Homestead, Pa.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.

Mueller Co., Decatur, Ill.

Reading Steel Castings Co., Bridgeport, Conn.

COCKS, Steam Stop

Homestead Valve Mfg. Co., Inc., Homestead, Pa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

Mueller Co., Decatur, Ill.

The Wm. Powell Co., Cincinnati, Ohio.

COCKS, Steam Stop Asbestos packed

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Reading Steel Castings Co., Bridgeport, Conn.

COCKS, Three-way & Four-way

H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.

Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.

Mueller Co., Decatur, Ill.

Reading Steel Castings Co., Bridgeport, Conn.

COCKS, Three-way and Four-way Boiler Blow-off

Homestead Valve Mfg. Co., Inc., Homestead, Pa.

COILS

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

Pittsburgh Pipe & Coil Bending Co., Pittsburgh, Pa.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

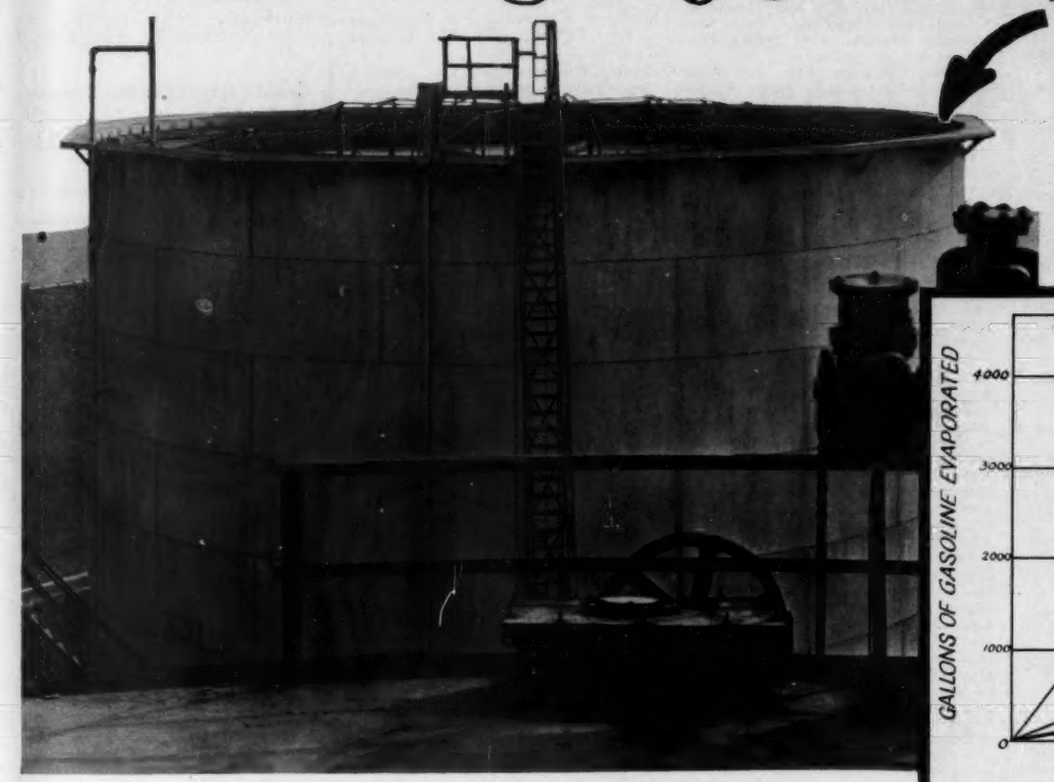
Roessing Manufacturing Company, Sharpsburg Sta., Pittsburgh, Pa.

United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

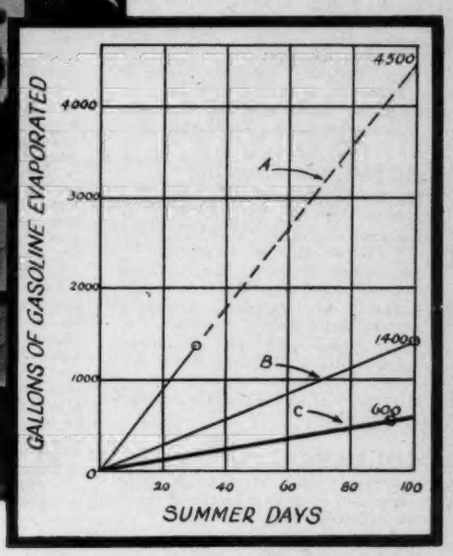
Henry Vogt Machine Co., Louisville, Ky.

York Ice Machinery Corporation, 2201 Texas Avenue, Houston, Texas.

A 7/8 inch adjustment right HERE saves 39 gal. of gasoline per day



60-ft. Wiggins Floating Roof on working tank in eastern refinery.



ONE of the surest ways to prove the effectiveness of the Wiggins Principle of sealing the space between the floating deck and the tank shell is to violate this principle. The close fit of the roof shoes to the tank shell only needs to be changed slightly to produce a surprising effect.

When the tall narrow slot is opened only an extra ¼ in. the evaporation from a 50-ft. diameter tank immediately increases from about 6 gal. to about 14 gal. per day. If the shoes are held away from the tank an extra ⅞ in. the loss jumps up to 45 gal.

It is obvious that no evaporation can take place under the deck of a floating roof. But no floating deck can fit the tank shell air-tight. Therefore, the all important feature of the floating roof is the means used for sealing this space. Experience verifies tests similar to the one cited above showing that the Wiggins principle—the tall narrow slot—eliminates evaporation almost completely in this annular space.

That's why Wiggins Floating Roofs are making such large savings on a wide variety of applications. They can, of course, show the greatest reduction in evaporation on working tanks. The Wiggins Breather Roof, a companion type, is particularly designed for standing storage. We have interesting literature on both these types. Ask for it.

Comparison of losses on Wiggins Roofs when sealed is varied as to efficiency. 63° A. P. I. Gasoline under a 50-ft. Wiggins Roof.

A—Inefficient seal. The Shoes were held away from tank an extra ⅞ in.—losing effect of tall slot. No secondary seal.

B—Inefficient seal. The shoes were held away an extra ¼ in. It is seen that some effect of the tall slot was restored. No secondary seal.

C—The Wiggins seal with its present efficiency. With secondary seal.

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Chicago—2463 Old Colony Bldg.
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BREATHER *for standing storage*

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Heat Transfer Products, Inc., 90 West St., New York, N. Y.

Roessing Manufacturing Company, Sharpsburg Sta., Pittsburgh, Pa.

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Henry Vogt Machine Co., Louisville, Ky.

COLLARS

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The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

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Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

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The Wm. Powell Co., Cincinnati, Ohio.

The Williams Gauge Co., 1620 Pennsylvania Ave., N. S., Pittsburgh, Pa.

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Manufacturers of IMPERIAL BOILER CLEANSER—the nearest to a perfect compound made and sold. Guaranteed—no cure, no pay. Absolutely best and cheapest.

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For the prevention and removal of scale, pitting and priming. Scientifically prepared. Have successfully handled most trying conditions for 30 years.

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Reiter Company, 259 North St., Elgin, Ill.

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For more than twenty-five years this company has devoted its time and efforts to the development of Chemical Feed Water Treatments, proving by the success of its products that the logical and economical method of maintaining clean and scale-proof boilers is by the proper use of properly combined chemicals.

RED STAR DRY COMPOUND is a combination of highly concentrated chemicals, finely powdered and readily soluble in water. Its action on the scale-forming solids in the feed water is positive, neutralizing and changing their nature, and precipitating them in a soft mud form, under which condition they are easily removed from the boiler by blowing down or washing out.

We have customers who have been using RED STAR continuously for twenty-five years. Such instances indicate a record of achievement and satisfactory service. Responsible concerns may take advantage of our "ninety days trial conditions" and if at the end of this period the compound used has not shown entirely satisfactory results the unused portion of the shipment may be returned to us and no charge will be made for the compound used during the trial period.

We also offer Concentrated Liquid Extract for Stationary and Marine Boilers. By our method of combining the chemicals used in RED STAR LIQUID EXTRACT, all moisture, with the exception of a sufficient quantity to prevent solidification of the chemicals is eliminated, the Baume, and of the consistency of heavy molasses, weighing about twelve and one-half pounds to the gallon.

Many large concerns who today are regular users of our RED STAR EXTRACT and whose purchases are closely scrutinized from the point of economy, are doing so after having made thorough and exhaustive comparative tests with other preparations which could be purchased at a lower price per pound, finding that our statements regarding the efficiency and economy of RED STAR EXTRACT were fully borne out by results obtained and consequently adopted the use of our material as a permanent boiler room economy.

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COMPOUNDS, Paint Stripping

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COMPOUNDS, Pipe Joints

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Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.

COMPOUNDS, Pipe, Merco

The Alloys Company, 121 Second Street, San Francisco, Calif.

COMPOUNDS, Rust Inhibitive

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

Reiter Company, 259 North St., Elgin, Ill.

Ward Chemical Co., Tulsa, Okla.

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Fluor Construction Co., 909 E. 59th St., Los Angeles, California.

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Bessemer Gas Engine Company, Grove City, Pa.

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Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.

CLARK BROS. CO., OLEAN, N. Y.

Clark gas engine driven compressors are suitable for gasoline plants, gas booster plants and in the operation of air or gas lift.

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De Laval Steam Turbine Co., Trenton, N. J.

The DeVilbiss Company, 300-306 Phillips Ave., Toledo, Ohio.

F. W. Gartner Company, Houston, Texas.

General Electric Co., Schenectady, New York.

Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.

Hope Engineering & Supply Co., Mt. Vernon, Ohio.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Maxon Premix Burner Co., Muncie, Ind.

May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.

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Rotary, high speed, direct connected compressors for pressures up to 50 pounds gauge. High efficiency, noiseless, compact, lightweight, automatically oiled, nothing to require adjustment, durable, dependable.

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General Electric Co., Schenectady, New York.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Southern Engine & Pump Co., 615 Washington Ave., Houston, Tex.

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Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.

COMPRESSORS, Ammonia

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Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

Henry Vogt Machine Co., Louisville, Ky.

York Ice Machinery Corporation, 2201 Texas Avenue, Houston, Texas.

COMPRESSORS, Carbon Dioxide

Wittenmeier Machinery Co., 850-860 N. Spaulding Ave., Chicago, Ill.

COMPRESSORS, Centrifugal

De Laval Steam Turbine Co., Trenton, N. J.

Elliott Co., Jeannette, Pa.

General Electric Co., Schenectady, New York.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

The Spencer Turbine Co., Hartford, Conn.

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CLARK BROS. CO., OLEAN, N. Y.

Clark gas engine driven compressors are suitable for gasoline plants, gas booster plants and in the operation of air or gas lift.

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Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.

De Laval Steam Turbine Co., Trenton, N. J.

General Electric Co., Schenectady, New York.

Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.

Hope Engineering & Supply Co., Mt. Vernon, Ohio.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

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The C. & G. Cooper Company, Mt. Vernon, Ohio.

General Electric Co., Schenectady, New York.

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Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Superior Gas Engine Co., Springfield, Ohio.

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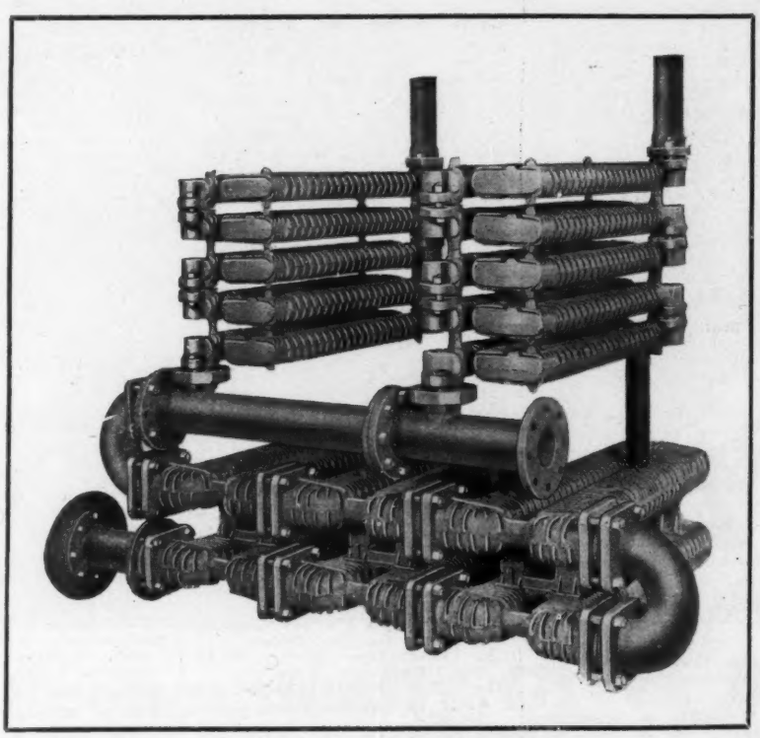
Simplicity Itself . .

a condenser *completely* assembled with Sterling Sections and accessories



LONGER LIFE

Of course—because Sterling Sections are made of the new corrosion resisting ARCO METAL.

Quick, inexpensive erection with ever-present ability to increase or decrease in size—to effect replacements without disturbing other sections—and to move quickly and easily to a new location.

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Industrial Division No. D

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Fisher Governor Co., Marshalltown, Iowa.

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The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.

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The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.

General Electric Co., Schenectady, New York.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.

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The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.

The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

International Filter Co., 333 West 25th Place, Chicago, Ill.

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The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.

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Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.

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To control the temperatures of Air, Gases and Liquids.

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Taylor Instrument Companies, Rochester, N. Y.

Wilson-Maeulen Co., Inc., 381 Concord Ave., New York, N. Y.

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The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.

The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.

Taylor Instrument Companies, Rochester, N. Y.

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CONVEYORS, Ash

Union Engineering Co., Cleveland, Ohio.

CONVEYORS, Pneumatic

Union Engineering Co., Cleveland, Ohio.

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C. F. Braun & Co., Alhambra, California.

The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.

Heat Transfer Products, Inc., 90 West St., New York, N. Y.

C. H. Leach Co., 255 Broadway Ave., New York, N. Y.

Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.

Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

C. H. Wheeler Mfg. Co., Philadelphia, Pa.

COOLERS, Water

Audiffren Refrigerating Machine Co., 285 Madison Ave., New York, N. Y.

C. F. Braun & Co., Alhambra, California.

Heat Transfer Products, Inc., 90 West St., New York, N. Y.

Power Plant Equipment Co., Coca Cola Bldg., Kansas City, Mo.

Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.

Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.

C. H. Wheeler Mfg. Co., Philadelphia, Pa.

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George B. Allan & Co., Simpson Building, Dallas, Texas.

American Radiator Co., 816 S. Michigan Ave., Chicago, Ill.

Binks Spray Equipment Co., 3114-26 Carroll Ave., Chicago, Ill.

The Cooling Tower Co., 15 John St., New York, N. Y.

The Power Plant Equipment Co., Coca Cola Building, Kansas City, Mo.

COOLING SYSTEMS, Spray Nozzle

Binks Spray Equipment Co., 3114-26 Carroll Ave., Chicago, Ill.

The Cooling Tower Co., 15 John St., New York, N. Y.

H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

The Power Plant Equipment Co., Coca Cola Building, Kansas City, Mo.

Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.

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The prohibitive cost of certain corrosion resisting alloys render them impractical for many oil refining applications. You can economically obtain these advantages with base metals, by applying a sprayed molten coating of the metal which best resists the specific destructive agent.

MetaLayeR "The Putting-onTool" applies coatings of any commercial metal on any surface at costs entirely within commercial limits. Sprayed molten coatings can be used for protection against sulphides, acids, erosion, abrasion, high temperatures, atmospheric corrosion and for preventing contamination of petroleum and its derivatives in process, storage or transit. The added service life obtained by coating Agitators, Tanks, Fractionating Stills and Connecting Lines for same, etc., will more than repay the cost of the sprayed molten coating.

We install the complete metal coating system, ready for profitable operation in your plant. Write for the MetaLayeR Book.

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Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.

CORKS, Rubber
Armstrong Cork Co., 24th St. and Allegheny River, Pittsburgh, Pa.
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Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

COUNTERSHAFTS
Joseph Reid Gas Engine Co., Oil City, Pa.

COUPLERS, Car
North American Car Corp., Petroleum Bldg., Tulsa, Okla.

COUPLINGS, Flexible
THE FALK CORPORATION, MILWAUKEE, WISCONSIN. The Falk Flexible Coupling is all steel and transmits load without loss of power, protects motor and driven machine. Used throughout industry by the largest manufacturers, it has proved it is not only efficient, but especially strong, giving a lifetime of satisfaction. Catalog and tables will be sent upon request.
General Electric Co., Schenectady, New York.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Houston Armature Works, Houston, Texas.
The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.
W. H. Nicholson & Co., 132 Oregon St., Wilkes-Barre, Pa.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.
John Waldron Corporation, New Brunswick, N. J.

COUPLINGS, Friction Clutch
Bessemer Gas Engine Company, Grove City, Pa.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.

COUPLINGS, Hose
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Dayton Pneumatic Tool Corp., 408 Ray St., Dayton, Ohio.

COUPLINGS, Pipe
Hope Engineering & Supply Co., Mt. Vernon, Ohio.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

COUPLINGS, Shaft
De Laval Steam Turbine Co., Trenton, N. J.
The Falk Corporation, Milwaukee, Wisconsin.
General Electric Co., Schenectady, New York.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.
W. H. Nicholson & Co., 132 Oregon St., Wilkes-Barre, Pa.

COVERS, Dome
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
The R. S. Manufacturing Co., 3404-06 Main St., Dallas, Texas.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

COVERS, Gauge, Thief Hole
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

COVERS, Handhole
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

COVERS, Manhole
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.
The Refinery Supply Company, Tulsa, Oklahoma.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

COVERINGS, High Pressure
R. V. Aycock Company, Kansas City, Mo.
Banner Rock Products Co., Alexandria, Indiana.
The Philip Carey Mfg. Co., Lockland, Ohio.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.

COVERINGS, Pipe
R. V. Aycock Company, Kansas City, Mo.
Banner Rock Products Co., Alexandria, Indiana.
The Philip Carey Mfg. Co., Lockland, Ohio.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.

COVERINGS, Roof Manhole
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

CRACKING PROCESS
Graver Corporation, East Chicago, Ind.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Universal Oil Products Co., 312 S. Michigan Ave., Chicago, Ill.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

CRANES
F. W. Gartner Company, Houston, Texas.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

CUTTERS, Flue
Lagonda Manufacturing Co., Springfield, Ohio.

CUTTERS, Pipe
The Armstrong Mfg. Co., 27 Cleveland Place, near Spring St., New York, N. Y.
Greenfield Tap & Die Corporation, Greenfield, Mass.

CUTTERS, Pneumatic Rivet
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.

CUTTERS, Tube
Lagonda Manufacturing Co., Springfield, Ohio.

CUTTING APPARATUS
Smith Welding Equipment Corporation, 2619-33 Fourth St., S. E., Minneapolis, Minn.

CYLINDERS, Glass
HYATT GLASS CO., POTEAU, OKLA. Underwriter approved glass cylinders for visible gasoline pumps.

D

DAMPERS
North American Car Corp., Petroleum Bldg., Tulsa, Okla.

DECONCENTRATORS
Reiter Company, 259 North St., Elgin, Ill.

DEHYDRATING, Equipment
Newton Process Mfg. Co., Fullerton, Calif.

DEPHLEGMATORS
E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
C. F. Braun & Co., Alhambra, California.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Hammond Iron Works, Warren, Pa.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Struthers-Wells Co., Warren, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.
Wyatt Metal & Boiler Works, Dallas, Texas.

DESUPERHEATERS
Elliott Co., Jeannette, Pa.

DEVICES, Filteration and Water Softening
Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.
International Filter Co., 333 West 25th Place, Chicago, Ill.
Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.

DIE HEADS
Landis Machine Co., Inc., Waynesboro, Pa.

DIE STOCKS, Plain
Greenfield Tap & Die Corporation, Greenfield, Mass.

DIES
Greenfield Tap & Die Corporation, Greenfield, Mass.

DIES, Pipe
Greenfield Tap & Die Corporation, Greenfield, Mass.
Jarecki Manufacturing Co., St. Louis, Mo.

DISTILLATION, Apparatus
American Radiator Co., 816 S. Michigan Ave., Chicago, Ill.
C. F. Braun & Co., Alhambra, California.
J. A. Campbell, P. O. Box 669, Long Beach, Calif.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
The Walter E. Lummus Co., 173 Milk St., Boston, Mass.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Precision Scientific Co., 1736-54 N. Springfield Ave., Chicago, Ill.
The Refinery Supply Company, Tulsa, Oklahoma.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Struthers-Wells Co., Warren, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

DOORS, Cast Iron
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.

DRAFTING, Apparatus
A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
Kolesch & Co., 138 Fulton St., New York, N. Y.
U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

DRAWING, Equipment
A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
Kolesch & Co., 138 Fulton St., New York, N. Y.
U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

DRAFTING ROOM, Furniture
A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
Kolesch & Co., 138 Fulton St., New York, N. Y.
New York Blue Print Paper Co., 96-102 Reade St., New York, N. Y.
U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

DRILLS, Cole
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

DRILLS, Compressed Air
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

DRILLS, Electric
A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Jas. Clark, Jr., Electric Co., 600 E. Bargman St., Louisville, Ky.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

DRILLS, Pneumatic

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

DRILLS, Rock

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

DRILLS, Twist

Greenfield Tap & Die Corporation, Greenfield, Mass.

DRIVERS, Hoop

Weimar Engineering Works, Jasper & Westmoreland Sts., Philadelphia, Pa.

DRUMS, Shipping

Geuder, Paeschke & Frey Co., St. Paul Ave. and 15th St., Milwaukee, Wis.
The Petroleum Iron Works Co., Sharon, Pa.

DRYERS

Buffalo Foundry & Machine Co., 1569 Fillmore Ave., Buffalo, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
The Petroleum Iron Works Co., Sharon, Pa.
Struthers-Wells Co., Warren, Pa.
Union Engineering Co., Cleveland, Ohio.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

DRYERS, Drum or Oven Type, Any Temperature

National Electric Heating Company, 420 Lexington Ave., New York, N. Y.

E

ECONOMIZERS

Erie City Iron Works, Erie City, Pa.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
B. P. LIENTZ & CO., 3409 EAST 18 ST., KANSAS CITY, MO.

EJECTORS

Blakeslee Mfg. Co., Du Quoin, Ill.
ELLIOTT CO., JEANNETTE, PA.
Elliott Ejectors are built in types to maintain any desired degree of vacuum. Booster (multi-stage) Ejectors create extremely high vacuum. Of utmost simplicity and compactness. No. moving parts.
The Ohio Injector Co., 247 Main St., Wadsworth, Ohio.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

EJECTORS, Air

C. H. Wheeler Mfg. Co., Philadelphia, Pa.

EJECTORS, Sewage

YEOMANS BROTHERS CO., 1424 DAYTON ST., CHICAGO, ILL.
Pneumatic (air operated) and nonclogging (centrifugal), submerged and dry pit sewage pumps are ejectors. Dependable, long life machines for all types of buildings and municipal work. High efficiency, low operating cost.

ELEVATORS, Bucket

Union Engineering Co., Cleveland, Ohio.

ELIMINATORS, Condensation

W. H. Nicholson & Co., 132 Oregon St., Wilkes-Barre, Pa.
Provident Engineering Co., 39 Cortlandt St., New York, N. Y.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

ELIMINATORS, Oil

Godfrey, Keeler Co., 70 Warren St., New York, N. Y.

ENAMEL, Metal

Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.

ENAMEL, Oil Proof Tank

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.

ENAMEL, Rust Proof Tank

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.

ENAMEL, Seepage Proof for Concrete

Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.

ENGINES

C. H. Wheeler Mfg. Co., Philadelphia, Pa.

ENGINES, Corliss

Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.

ENGINES, Diesel

Bessemer Gas Engine Company, Grove City, Pa.
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
The C. & G. Cooper Company, Mt. Vernon, Ohio.
Southern Engine & Pump Co., 615 Washington Ave., Houston, Tex.
Wolverine Motor Works, 35 Union Ave., Bridgeport, Conn.

ENGINE, Gas

Bessemer Gas Engine Company, Grove City, Pa.
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
CLARK BROS. CO., OLEAN, N. Y.
Clark gas engines are built in sizes ranging from 40 H. P. to 400 H. P. These units can either be direct to compressors or generators, and also used for belt driving pumps, line shafts, etc.
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F. W. Gartner Company, Houston, Texas.
Hope Engineering & Supply Co., Mt. Vernon, Ohio.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Marion Machine, Foundary & Supply Co., Box No. 685, Marion, Ind.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Joseph Reid Gas Engine Co., Oil City, Pa.
Southern Engine & Pump Co., 615 Washington Ave., Houston, Tex.
Sterling Engine Co., 1252-1274 Niagara St., Buffalo, N. Y.
Superior Gas Engine Co., Springfield, Ohio.
Titusville Iron Works Co., Titusville, Pa.
Witte Engine Works, 16th and Oakland Ave., Kansas City, Mo.
Wolverine Motor Works, 35 Union Ave., Bridgeport, Conn.

ENGINES, Gasoline

Bessemer Gas Engine Company, Grove City, Pa.
Sterling Engine Co., 1252-1274 Niagara St., Buffalo, N. Y.
Witte Engine Works, 16th and Oakland Ave., Kansas City, Mo.
Wolverine Motor Works, 35 Union Ave., Bridgeport, Conn.

ENGINES, Hoist

Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.

ENGINES, Kerosene

Witte Engine Works, 16th and Oakland Ave., Kansas City, Mo.

ENGINES, Oil

Bessemer Gas Engine Company, Grove City, Pa.
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
The C. & G. Cooper Company, Mt. Vernon, Ohio.
De La Vergne Machine Co., 910 East 138th St., New York, N. Y.
The Falk Corporation, Milwaukee, Wisconsin.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Joseph Reid Gas Engine Co., Oil City, Pa.
Superior Gas Engine Co., Springfield, Ohio.
Wolverine Motor Works, 35 Union Ave., Bridgeport, Conn.

ENGINES, Pumping

Sterling Engine Co., 1252-1274 Niagara St., Buffalo, N. Y.

ENGINES, Steam

Elliott Co., Jeannette, Pa.
Erie Ball & Engine Co., Pittsburgh, Pa.
Erie City Iron Works, Erie City, Pa.
Godfrey, Keeler Co., 70 Warren St., New York, N. Y.
Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.
The James Leffel & Co., Springfield, Ohio.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Titusville Iron Works Co., Titusville, Pa.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

ENGINES, Well Drilling

Sterling Engine Co., 1252-1274 Niagara St., Buffalo, N. Y.

EQUIPMENT, Electrically Heated

NATIONAL ELECTRIC HEATING COMPANY, 420 LEXINGTON AVE., NEW YORK, N. Y. NEHCO electrically heated equipment can be furnished in any size or heating capacity up to 1,000,000 B. T. U. per hr., with close automatic control at any temperature from 100 to 1000° F., constructed of non-corrosive metal or any desired material for any purpose.

EQUIPMENT, Heat Transfer

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EQUIPMENT, Hospital

Frank S. Betz Co., Hammond, Ind.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

EQUIPMENT, Leak Sealing

THE FURMANITE CORPORATION, NEWPORT NEWS, VA.
Manufacturers of Leak Sealing Equipment for sealing leaks in bolted flange joints or joints in screw thread piping while full pressure is on the piping.

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The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Modern Engineering Co., 3411 Pine Blvd., St. Louis, Mo.
Prest-O-Lite Co., Inc., New York, N. Y.
Smith Welding Equipment Corporation, 2619-33 Fourth St., S. E., Minneapolis, Minn.

EQUIPMENT, Pumping

INDIANA AIR PUMP CO., 816 INDIANA PYTHIAN BLDG., INDIANAPOLIS, IND.
INDIANA AIR-LIFT PUMPING EQUIPMENTS complete for any part are furnished covering Air Lift Pumps, Air Compressor, Motors or Engine and Accessories; for Oil or Water.

EQUIPMENT, Safety

Northern Valve Co., 806 Union St., Utica, N. Y.

EQUIPMENT, Wash Room

POWERS REGULATOR CO., 2776 GREENVIEW AVE., CHICAGO, ILL.
Hot and Cold Water Mixers, Steam and Cold Water Mixers, Shower Mixers, Faucets and Shower Heads.

EVAPORATORS

Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Buffalo Foundry & Machine Co., 1559 Fillmore Ave., Buffalo, N. Y.
J. A. Campbell, P. O. Box 669, Long Beach, Calif.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Hammond Iron Works, Warren, Pa.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Newton Process Mfg. Co., Fullerton, Calif.
The Petroleum Iron Works Co., Sharon, Pa.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

EVAPORATORS, Lead Lined

Heat Transfer Products, Inc., 90 West St., New York, N. Y.

EXCHANGERS, Reflux

A. O. Smith Corporation, Milwaukee, Wisconsin.

EXHAUSTERS

De Laval Steam Turbine Co., Trenton, N. J.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.
Wilbraham Green Blowers Co., Pottstown, Pa.

EXHAUSTERS, Gas

The Connersville Blower Co., Connersville, Ind.
Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady, New York.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
Wilbraham Green Blowers Co., Pottstown, Pa.

EXHAUSTERS, Lead Lined

The Connersville Blower Co., Connersville, Ind.

EXHAUSTERS, Steam Jet
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

EXPANDERS, Boiler Tube
A. L. Henderer's Sons, Maryland Ave. and Beech St., Wilmington, Delaware.

Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.

EXPANDERS, Still Tube
A. L. Henderer's Sons, Maryland Ave. and Beech St., Wilmington, Delaware.

The "Henderer" Expanders are made for the smallest condenser tubes on up to the largest cracking still tubes. To plain roll, also to roll and flare ends of tubes at same operation.

Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.

EXTRACTORS, Mist
The Baltimore Gas Engineering Corporation, Box 824, Charleston, West Virginia.

F

FANS
General Electric Co., Schenectady, New York.

Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.

EXHAUST FANS, Acid Resisting
The Duriron Company, Inc., Dayton, Ohio.

FANS, Ventilator
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.

FEEDERS, Boiler
De Laval Steam Turbine Co., Trenton, N. J.

H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

FEEDERS, Boiler Compound
Fisher Governor Co., Marshalltown, Iowa.

Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.

International Filter Co., 333 West 25th Place, Chicago, Ill.

Lake Erie Manufacturing Co., Inc., 192-198 Chicago St., Buffalo, N. Y.

FELT, Asbestos Pipe Line
The Philip Carey Mfg. Co., Lockland, Ohio.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

Keasbey & Mattison Co., Ambler, Pa.

Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

FELT, Hair
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

FENCE
Pittsburgh Steel Products Co., Union Arcade Bldg., Pittsburgh, Pa.

FIBRE, Asbestos
The Philip Carey Mfg. Co., Lockland, Ohio.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

FILLER, Iron Paste
Detroit Graphite Company, Detroit, Mich.

FILTER PRESSES
WILLIAM R. PERRIN & CO., 341 S. DEARBORN ST., CHICAGO, ILL.

Manufacturers of Filter Presses with recessed plates or flat plates and cake frames, made of cast iron.

FILTER, Air
The Cooling Tower Co., 15 John St., New York, N. Y.

Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.

Henry Vogt Machine Co., Louisville, Ky.

FILTERS, Oil
S. F. Bowser & Co., Inc., 1230 Bowser Ave., Fort Wayne, Ind.

Burt Manufacturing Company, 929 S. High, Akron, Ohio.

General Electric Co., Schenectady, New York.

Hammond Iron Works, Warren, Pa.

Wm. W. Nugent & Co., 410-12 N. Hermitage Ave., Chicago, Ill.

FILTERS, Water
American Water Softener Co., Lehigh Ave., at 4th St., Philadelphia, Pa.

C. F. Braun & Co., Alhambra, California.

Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.

Elliott Co., Jeannette, Pa.

Graver Corporation, East Chicago, Ind.

International Filter Co., 333 West 25th Place, Chicago, Ill.

H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

PERMUTIT CO., 440 FOURTH AVE., NEW YORK, N. Y.

Pressure and gravity types of filters are built for every purpose, and may be had with chemical feeding devices, mechanical agitation and similar accessories when needed.

FIRE APPARATUS, Motorized
Byron Jackson Pump Co., Berkeley, Calif.

FIRE EXTINGUISHERS
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

M. L. Snyder & Son, 116 No. 3rd St., Philadelphia, Pa.

FIREPROOFING MATERIALS
R. V. Aycock Company, Kansas City, Mo.

Banner Rock Products Co., Alexandria, Indiana.

Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh, Pa.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

Keasbey & Mattison Co., Ambler, Pa.

FIRST AID SUPPLIES
Frank S. Betz Co., Hammond, Ind.

First Aid Equipment & Supply Co., 1446 West Slauson Ave., Los Angeles, Calif.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y.

FITTINGS, Ammonia
Frick Company, Inc., Waynesboro, Pa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

FITTINGS, Boiler
Northern Valve Co., 806 Union St., Utica, N. Y.

The Ohio Steel Foundry Co., Springfield, Ohio.

FITTINGS, Brass or Bronze
Kennedy Valve Mfg. Co., Elmira, New York.

FITTINGS, Cast Iron
American Cast Iron Pipe Co., P. O. Box 151-152, Birmingham, Alabama.

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Jarecki Manufacturing Co., St. Louis, Mo.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

Westcott Valve Co., East St. Louis, Ill.

FITTINGS, Cast Steel
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Hughes Tool Co., 300 Hughes St., Houston, Texas.

Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

The Ohio Steel Foundry Co., Springfield, Ohio.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Reading Steel Castings Co., Bridgeport, Conn.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

FITTINGS, Compression
Wm. W. Nugent & Co., 410-12 N. Hermitage Ave., Chicago, Ill.

FITTINGS, Drop-Forged
The Hydraulic Press Mfg. Co., 20 East Broad, Columbus, Ohio.

Geo B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Reading Steel Castings Co., Bridgeport, Conn.

FITTINGS, Flanged
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Jarecki Manufacturing Co., St. Louis, Mo.

Kennedy Valve Mfg. Co., Elmira, New York.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

The Ohio Steel Foundry Co., Springfield, Ohio.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Henry Vogt Machine Co., Louisville, Ky.

WESTCOTT VALVE CO., EAST ST. LOUIS, ILL.

Standard and extra heavy flanged fittings, tees, ells, crosses, Ys, etc. Special manifolds.

FITTINGS, Flanged Steel
Hughes Tool Co., 300 Hughes St., Houston, Texas.

Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Malleable Iron Fittings Co., Branford, Conn.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

The Ohio Steel Foundry Co., Springfield, Ohio.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Reading Steel Castings Co., Bridgeport, Conn.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Henry Vogt Machine Co., Louisville, Ky.

FITTINGS, Gauge Glass
H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.

FITTINGS, Hydraulic
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

The Hydraulic Press Mfg. Co., 20 East Broad, Columbus, Ohio.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Pennsylvania Forge Company, Philadelphia, Pa.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Henry Vogt Machine Co., Louisville, Ky.

Westcott Valve Co., East St. Louis, Ill.

FITTINGS, Long Sweep
Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

FITTINGS, Malleable Screwed
Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Jarecki Manufacturing Co., St. Louis, Mo.

Kennedy Valve Mfg. Co., Elmira, New York.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Malleable Iron Fittings Co., Branford, Conn.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

FITTINGS, Pipe
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Jarecki Manufacturing Co., St. Louis, Mo.

Kennedy Valve Mfg. Co., Elmira, New York.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

The Wm. Powell Co., Cincinnati, Ohio.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Reading Steel Castings Co., Bridgeport, Conn.

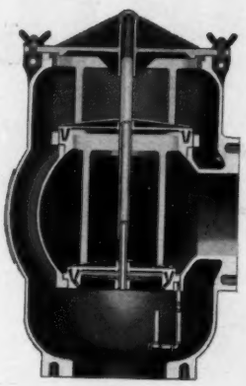
Stockham Pipe & Fittings Co., Birmingham, Alabama.

Henry Vogt Machine Co., Louisville, Ky.

Westcott Valve Co., East St. Louis, Ill.

SALES and SERVICE

WESTCOTT & GREIS INC. W&G MEASUREMENT & CONTROL



WESTCOTT & GREIS
Universal Valve

Better Protection for Oil Storage

The WESTCOTT & GREIS Universal Safety Valve provides a hitherto unknown degree of protection for oil storage. This valve has a number of important new features which reduce evaporation and fire hazard to the very minimum. It soon saves more than its cost in decreased evaporation losses and lower insurance premiums.

A double mechanical seat is provided for use when a liquid seat is not practical. By simply adding liquid a combination liquid and mechanical seal is secured. Discs are guided both by central and outside guides, the central guides preventing tilting and binding of discs. Extreme sensitiveness, the largest capacity of any safety valve on the market, and enclosure of the entire valve mechanism in an easily removable cage, are other notable features.

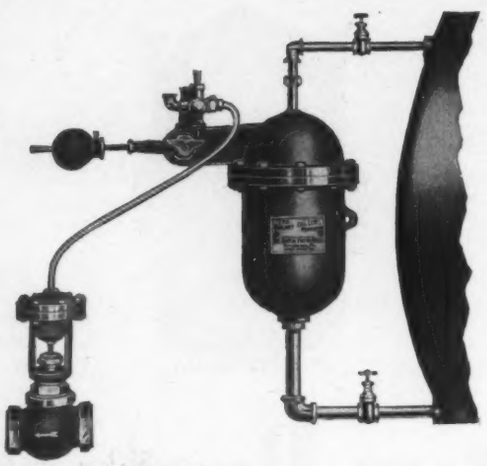
Call on us for complete information regarding the WESTCOTT & GREIS Universal Safety Valve and other conservation and safety equipment such as Flame Arrestors, Thief Hatches, Mechanical Manhole Covers, etc. We maintain a staff of engineers who are specialists in all matters pertaining to conservation and safety in the oil industry.

WESTCOTT & GREIS, Inc.

DALLAS TULSA LOS ANGELES

Westcott & Greis, Inc.
MEASUREMENT AND CONTROL

SALES and WESTCOTT & GREIS INC. W&G MEASUREMENT & CONTROL SERVICE



Dependable—of course

The Vigilant Liquid Level Regulator, by remote control, is designed to maintain a constant oil level in both the absorbing tank and the still, where gasoline is manufactured by absorbing the gasoline in oil and subsequently separating it from the oil by distillation.

This regulator will accommodate itself to any type of absorber or steam still, and maintain a constant oil level under pressure.

Thirty-five years of successful experience in the manufacture of regulators assure to the purchaser absolute accurate and reliable equipment.

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The Chaplin-Fulton Mfg. Co.

Organized 1884—Oldest builders of Gas Regulators in the Country. Built in all Sizes From 1 Inch to 24 Inches; For All Service. 1 oz. up to 1600 lbs. Pressure to Square Inch.

28-40 Penn Avenue **Pittsburgh, Pa.**

Westcott & Greis, Inc.
MEASUREMENT AND CONTROL

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WESTCOTT & GREIS INC. W&G MEASUREMENT & CONTROL

Accuracy—Concentrated

METERS METRIC

COMING from many sources, going to many places, to do many things—Gas can be exactly tabulated by Metric orifice Meters, grouped side by side, for convenient readings by one person. In an installation, such as this, all charts can be changed and the necessary attention given in a very short time. Such a concentration of accurate measurement pays daily dividends in the exactness of the records made, and in the little effort required to secure and maintain those records.

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of the American Meter Company, Inc.
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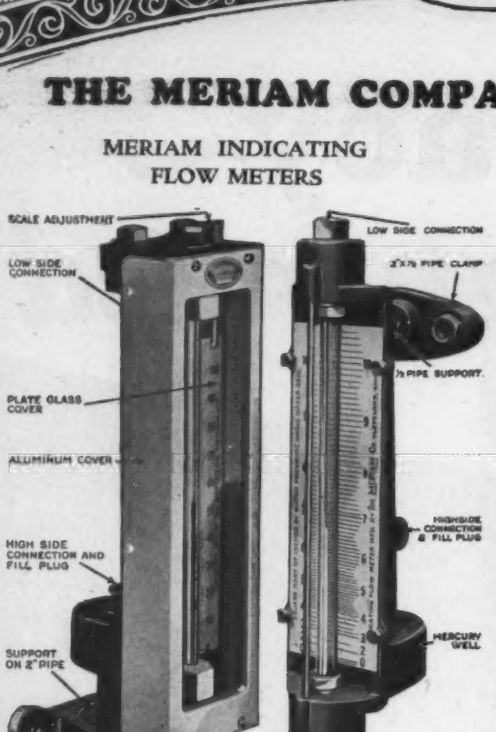
Westcott & Greis, Inc.
MEASUREMENT AND CONTROL

SALES and WESTCOTT & GREIS INC. W&G MEASUREMENT & CONTROL SERVICE

THE MERIAM COMPANY, Cleveland, Ohio

MERIAM INDICATING FLOW METERS



Type "E" *Type "D"*

The operation of these Single Reading Indicating Flow Meters is very simple as shown by Meriam Blue Prints C-188 and C-200.

No Springs; No Gears; the sole influence on the column of Mercury being the difference in pressure on the two sides of the orifice.

For years the Meriam "U" Type Manometer has been accepted as standard and these Single Reading Indicating Flow Meters combine the principle of this standard "U" Type manometer with the well known orifice.

Primarily designed for high line pressure up to 1000 pounds, with a slight change in the connection they are used as satisfactorily on Low Line Pressures.

Type "D" and Type "E" when so ordered, come to you with piping connections, (as shown in Meriam Blue Print C-212), Unions and High Pressure Steel Needle Valves, all properly connected, leak tested and ready for service connections to Inlet and Outlet.

This makes a very serviceable and easily handled unit and by reason of production in quantities the price is low.

Orifice Flanges and Discs are also furnished on order for all size pipe lines.

Type "E" is equipped with an overflow Mercury Chamber, an Aluminum Cover, a Heavy Plate Glass Cover and an outside Scale Adjustment.

To their popular "U" Type Low Pressure Manometer

MERIAM "U" TYPE MANOMETERS

30" S G P *50" S S H*

line, the Meriam Company has added two High Pressure Lines;

SPECIAL GLAND PACKED

This line, known as the Meriam S G P "U" Type Manometer is to be used for determining differential where line pressures exceed 30 pounds or where extreme care is to be exercised against leakage.

The heads of these manometers are machined for the glands which serve the double purpose of holding the packing and providing ¼" connections.

Heavy Locking Bar, short nipple and Unions form a part of the equipment of the 30" size, (illustrated), and the 50" size. This Type is also made in a semi-steel 50" size.

SPECIAL STEEL HEADER

This Type is used for determining differential where line pressures exceed 300 pounds and is known as the Meriam S S H "U" Type Manometer.

These manometers have a specially designed packing gland cast into and forming a permanent part of the instrument. Furnished only in the 30" size and the 50" size, (illustrated).

PERFECT VACUUM MANOMETERS

The 30" S G P Meriam Manometer, (illustrated) is also used where it is necessary to pull an absolute or nearly perfect Vacuum. Its range is 31", 15 lbs. or 780 millimeters.

It is sometimes necessary in pulling close vacuums to center the eye on the top of the mercury column. In such cases to facilitate reading, specially calibrated glass tubes are furnished when ordered and the single reading to the right of the top of the mercury is all that is necessary.

Any Meriam "U" Type Manometer may be used to indicate Pressure, or Vacuum or Differential.

In our stores at Tulsa, at Dallas and at Los Angeles you will find a complete stock of Meriam Manometers, both "U" and "Well" Types, Meriam Indicating Flow Meters, Meriam Draft Gauges and Meriam Pulsation Shock Absorbers. Bulletins covering these various lines sent on request.

Westcott & Greis. Inc.
MEASUREMENT AND CONTROL

FITTINGS, Pipe Line

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Westcott Valve Co., East St. Louis, Ill.

FITTINGS, Steam Jacketed

GUYTON & CUMFER MFG. CO., 4441-59 FILLMORE ST., CHICAGO, ILL.

Guyton & Cumfer Mfg. Co., "Guycumbo."

FITTINGS, Steel

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

The Ohio Steel Foundry Co., Springfield, Ohio.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Reading Steel Castings Co., Bridgeport, Conn.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Henry Vogt Machine Co., Louisville, Ky.

FITTINGS, Tank

Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

Northern Valve Co., 806 Union St., Utica, N. Y.

The Ohio Steel Foundry Co., Springfield, Ohio.

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Westcott Valve Co., East St. Louis, Ill.

FITTINGS, Union

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Malleable Iron Fittings Co., Banford, Conn.

The Wm. Powell Co., Cincinnati, Ohio.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Henry Vogt Machine Co., Louisville, Ky.

FLANGES, Cast Iron

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Fisher Governor Co., Marshalltown, Iowa.

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Jarecki Manufacturing Co., St. Louis, Mo.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

The Wm. Powell Co., Cincinnati, Ohio.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Westcott Valve Co., East St. Louis, Ill.

FLANGES, Cast Steel

Fisher Governor Co., Marshalltown, Iowa.

Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Malleable Iron Fittings Co., Banford, Conn.

The Ohio Steel Foundry Co., Springfield, Ohio.

The Wm. Powell Co., Cincinnati, Ohio.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Reading Steel Castings Co., Bridgeport, Conn.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

FLANGES, Companion

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Kennedy Valve Mfg. Co., Elmira, New York.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

The Ohio Steel Foundry Co., Springfield, Ohio.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Westcott Valve Co., East St. Louis, Ill.

FLANGES, Dished Head

The Ohio Steel Foundry Co., Springfield, Ohio.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

FLANGES, Floor

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

FLANGES, Forged Steel

Endicott Forging & Mfg. Co., Inc., Endicott, New York.

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

The Hydraulic Press Mfg. Co., 20 East Broad, Columbus, Ohio.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

Pennsylvania Forge Company, Philadelphia, Pa.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Reading Steel Castings Co., Bridgeport, Conn.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Henry Vogt Machine Co., Louisville, Ky.

FLANGES, Orifice

The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.

FLANGES, Pipe

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Kennedy Valve Mfg. Co., Elmira, New York.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

The Ohio Steel Foundry Co., Springfield, Ohio.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Stockham Pipe & Fittings Co., Birmingham, Alabama.

Westcott Valve Co., East St. Louis, Ill.

FLANGES, Pressed Steel

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

FLANGES, Roof

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

FLANGES, Saddle

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

FLANGES, Welding

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Henry Vogt Machine Co., Louisville, Ky.

FLOATS, Seamless Copper

Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.

FLOATS, Steel

Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.

W. H. Nicholson & Co., 132 Oregon St., Wilkes-Barre, Pa.

FLOOR, Gratings

Blaw-Knox Co., Pittsburgh, Pa.

Kerlow Steel Flooring Company, 218-222 Culver Ave., Jersey City, N. J.

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

FLOORING, Cork

L. Mundet & Son, Inc., 461 8th Ave., New York, N. Y.

FLOORING, Steel, Open

Kerlow Steel Flooring Company, 218-222 Culver Ave., Jersey City, N. J.

FLOORING, Ventilating

Kerlow Steel Flooring Company, 218-222 Culver Ave., Jersey City, N. J.

FLUES, Boiler

The Babcock & Wilcox Tube Co., 85 Liberty St., New York, N. Y.

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

FLUX, Soldering

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.

FORGES

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

FORGES, Rivet

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

Furness Bros. Company, 1615 West Walnut St., Chicago, Ill.

HAUCK MANUFACTURING CO., 127 TENTH ST., BROOKLYN, N. Y.
Safety suction type, approved by Underwriters' Laboratory.

May Machinery Co., Second Natl. Bank Bldg., Houston, Texas.

FORGES, Rivet, Oil Fuel

The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.

FORGINGS

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

Pennsylvania Forge Company, Philadelphia, Pa.

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.

We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.

A trial order will convince you that we are the proper source of supply for your steel requirements.

Henry Vogt Machine Co., Louisville, Ky.

Vulcan Steam Forging Co., 247 Rano St., Buffalo, N. Y.

FORGINGS, Drop

Endicott Forging & Mfg. Co., Inc., Endicott, New York.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

FORGINGS, Hollow

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Pennsylvania Forge Company, Philadelphia, Pa.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Vulcan Steam Forging Co., 247 Rano St., Buffalo, N. Y.

FORGINGS, Monel Metal

Equitable Equipment Company, Inc., 410 Camp St., New Orleans, La.

FORGINGS, Non-Corrosive

Cyclops Steel Co., Titusville, Pa.

FORGINGS, Special

Cyclops Steel Co., Titusville, Pa.

Pennsylvania Forge Company, Philadelphia, Pa.

Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.

Seamless Steel Equipment Corp., 39 Broadway, New York, N. Y.

Vulcan Steam Forging Co., 247 Rano St., Buffalo, N. Y.

FORGINGS, Steel

A. R. PURDY CO., INC., 790-4 GREENWICH ST., NEW YORK, N. Y.

We specialize in Cold Rolled Shafting, Spring and Tool Steel, in bars and sheets, Alloy Steels to S. A. E. specifications, High Speed Bars and Bits, Forgings, etc. A trial order will convince you that we are the proper source of supply for your steel requirements.

FORMS, Concrete

Blaw-Knox Co., Pittsburgh, Pa.

F. W. Gartner Company, Houston, Texas.

FOUNTAINS, Drinking

Audiffren Refrigerating Machine Co., 285 Madison Ave., New York, N. Y.

FRACTIONATORS

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.

The Baltimore Gas Engineering Corporation, Box 824, Charleston, West Virginia.

C. F. Braun & Co., Alhambra, California.

Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.

Heat Transfer Products, Inc., 90 West St., New York, N. Y.

M. W. Kellogg Co., 7 Day St., New York, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

FRONTS, Boiler

Titusville Iron Works Co., Titusville, Pa.

FRONTS, Still

Barnhart-Davis Co., Warren, Pa
Titusville Iron Works Co., Titusville, Pa.

FULLERS EARTH

SOUTHERN REFRACTORIES CO., FT. PAYNE, ALA.
Ladd Fullers Earth Co., Fort Payne, Ala.
Ward Chemical Co., Tulsa, Okla.

FURNACE, Walls

BERNITZ FURNACE APPLIANCE CO., 80 FEDERAL ST., BOSTON, MASS.
Bernitz "clinker-proof, long-life" furnace walls are made for stoker, oil, pulverized fuel and hand fired furnaces of all types. Bernitz Air Cooled Carbo.undum and Fireclay Blocks are carried in stock for furnace walls, floors and arches.
Also manufacture Refractory Blocks for covering tubes of water cooled furnace walls.
Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
M. H. Detrick Co., Board of Trade Bldg., Portland, Oregon.
Erie City Iron Works, Erie City, Pa.
King Refractories Co., Inc., 1715 Niagara St., Buffalo, N. Y.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.

FURNACES

M. H. Detrick Co., Board of Trade Bldg., Portland, Ore.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Gas Combustion Company, P. O. Box 1753, Pittsburgh, Pa.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

FURNACES, Boiler

Bernitz Furnace Appliance Co., 80 Federal St., Boston, Mass. See listing under Furnace Walls.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Erie City Iron Works, Erie City, Pa.
Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.

FURNACES, Carborundem

Bernitz Furnace Appliance Co., 80 Federal St., Boston, Mass. See listing under Furnace Walls.

FURNACES, Diffusing

General Electric Co., Schenectady, New York.

FURNACES, Heat Treating

May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

FURNACES, Lead Melting

Hauck Manufacturing Co., 126-134 Tenth St., Brooklyn, N. Y.

FURNACES, Water Cooled

Erie City Iron Works, Erie City, Pa.

G

GAS, Oxygen and Hydrogen

National Oxygen Co., 29 S. LaSalle St., Chicago, Ill.

GASES, Acetylene for Oxy-Acetylene Welding and Cutting

The Linde Air Products Company, 30 East 42nd St., New York, N. Y.
Prest-O-Lite Co., Inc., 30 East 42nd St., New York, N. Y.

GASKETS, Aluminum

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.
R. V. Aycock Company, Kansas City, Mo.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.

GASKETS, Asbestos

R. V. Aycock Company, Kansas City, Mo.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.
Garlock Packing Co., Palmyra, N. Y.
General Asbestos & Rubber Co., P. O. Box 67, North Charleston, S. C.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., P. O. Box 151, New Brunswick, N. J.
New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.
Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.
Strong Machinery & Supply Co., 121 Spring St., New York, N. Y.

GASKETS, Boiler

R. V. Aycock Company, Kansas City, Mo.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Crandall Packing Company, Palmyra, New York.
Flexitallic Gasket Co., 8th and Bailey Sts., Camden, N. J.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.

GASKETS, Cork

Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.

GASKETS, Corrugated Copper

R. V. Aycock Company, Kansas City, Mo.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.

GASKETS, Double Fold

Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.

GASKETS, Felt

Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.

GASKETS, Handhole

R. V. Aycock Company, Kansas City, Mo.
Crandall Packing Company, Palmyra, New York.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Flexitallic Gasket Co., 8th and Bailey Sts., Camden, N. J.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

GASKETS, Leather

The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.

GASKETS, Manhole

R. V. Aycock Company, Kansas City, Mo.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Crandall Packing Company, Palmyra, New York.
Flexitallic Gasket Co., 8th and Bailey Sts., Camden, N. J.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

GASKETS, Metal

R. V. Aycock Company, Kansas City, Mo.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Flexitallic Gasket Co., 8th and Bailey Sts., Camden, N. J.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.

GASKETS, Oil

Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.
Strong Machinery & Supply Co., 121 Spring St., New York, N. Y.

GASKETS, Paper

Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.

GASKETS, Rubber

R. V. Aycock Company, Kansas City, Mo.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.
Voorhees Rubber Mfg. Co., 105 Hudson St., New York, N. Y.

GASKETS, Steam

Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Flexitallic Gasket Co., 8th and Bailey Sts., Camden, N. J.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., P. O. Box 175, New Brunswick, N. J.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.

GASKETS, Steel Refinery Style

Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.

GASKETS, Vulcanized Fibre

Garlock Packing Co., Palmyra, N. Y.
Griebel Instrument Co., Carbondale, Pa.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Metallo Gasket Co., 12 to 20 Bethany St., New Brunswick, N. J.

GAUGES, Air

American Schaeffer & Budenberg Corp., 338 Berry St., Brooklyn, N. Y.
Chas. J. Clark Blast Meter Co., Gladbrook, Iowa.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Gauge and Equipment Company, La Crosse, Wis.

GAUGES, Ammonia

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Griebel Instrument Co., Carbondale, Pa.
National Gauge Company, 300 Pacific St., Brooklyn, N. Y.
Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.
Henry Vogt Machine Co., Louisville, Ky.
Carl H. Wagner & Sons, 1944 W. Albany Ave., Chicago, Ill.
York Ice Machinery Corporation, 2201 Texas Avenue, Houston, Texas.

GAUGES, Automatic Tank

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

NATURALINE

The Super *aviation motor* Fuel .....

Airports springing up all over the country present a new opportunity to the oil jobber if he is handling a product that is suitable. Naturaline favors every need of the Aeroplane Motor. It is now ready for distribution. Airports could be quickly supplied within your territory. Wherever Naturaline is sold there will be an instant and appreciative recognition by visiting pilots. If you take a Naturaline franchise now you will reap the benefits from the great rush of Aviation development within the next few years. Write for our booklet "Tail winds and happy landings." It will explain your opportunity.

Made From Natural Gasoline

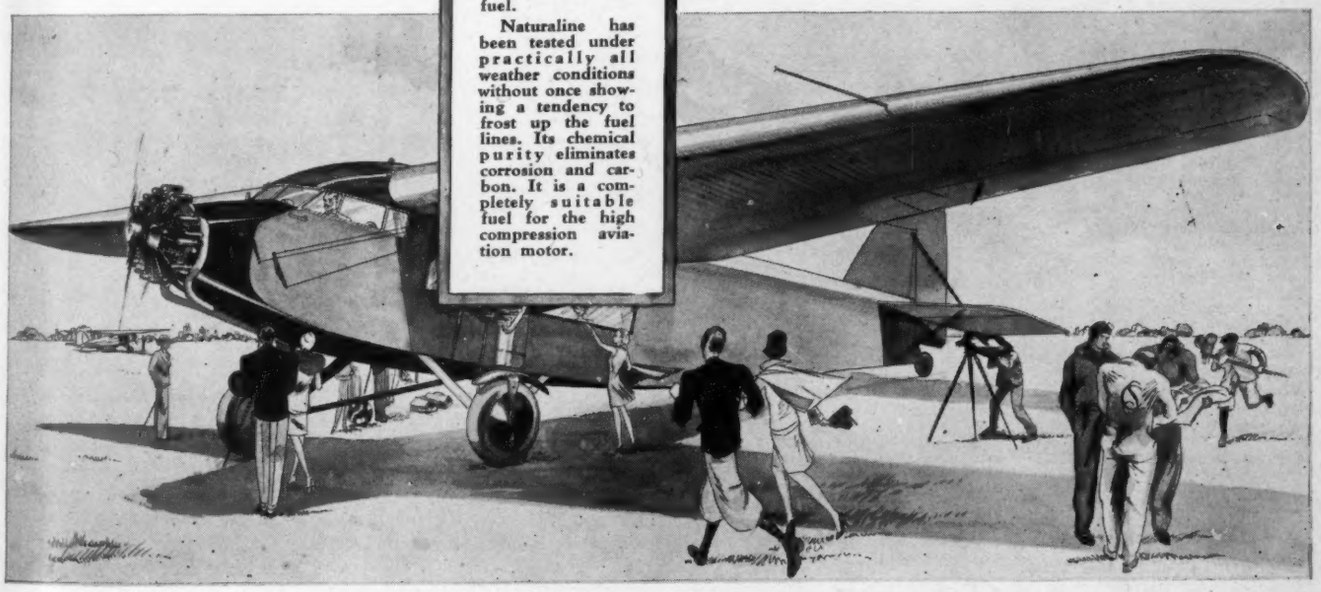
The urgent need for a suitable aviation fuel came to the realization of Chestnut & Smith Corporation nearly two years ago. It was realized too, that natural gasoline offered probably the most suitable source from which to produce such a fuel.

Aviation fuel shoals were charted to learn what fuel was best adapted to every type of aviation motor and after prodigious study and experiment NATURALINE was released to the flying public. This research developed many interesting facts about the fuel requirements of the modern type of aviation motor.

Actual tests in flight in all types of ships and motors soon taught us further valuable lessons. Pilots enlisted in our aid, were intensely interested in the effort being made to give them a dependable, efficient fuel and showed a ready willingness to test fuels, helping us tear down and build up until the ultimate goal was reached.

It is forty-six pounds per hundred gallons lighter than U. S. domestic aviation motor fuel.

Naturaline has been tested under practically all weather conditions without once showing a tendency to frost up the fuel lines. Its chemical purity eliminates corrosion and carbon. It is a completely suitable fuel for the high compression aviation motor.



NATURALINE
A SUPER AVIATION MOTOR FUEL

CHESTNUT & SMITH
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Tulsa, Oklahoma

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The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

GAUGES, Draft

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
The Hays Corporation, 1042 East Eighth St., Michigan City, Indiana.
The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.
Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.
Taylor Instrument Companies, Rochester, N. Y.

GAUGES, Indicating

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Chas. J. Clark Blast Meter Co., Gladbrook, Iowa.
Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
The Hays Corporation, 1042 East Eighth St., Michigan City, Indiana.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.
Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.
Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

GAUGES, Liquid Level

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.
Fisher Governor Co., Marshalltown, Iowa.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

GAUGES, Low Pressure

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Taylor Instrument Companies, Rochester, N. Y.

GAUGES, Mercury Tank

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
Griebel Instrument Co., Carbondale, Pa.
The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.
National Gauge Company, 300 Pacific St., Brooklyn, N. Y.

GAUGES, Open Mercury

National Gauge Company, 300 Pacific St., Brooklyn, N. Y.

GAUGES, Oil

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
National Gauge and Equipment Company, La Crosse, Wis.
The Wm. Powell Co., Cincinnati, Ohio.

GAUGES, Pressure

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.
The Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.
Chas. J. Clark Blast Meter Co., Gladbrook, Iowa.
Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.
Metric Metal Works, Erie, Pa.
National Gauge Company, 300 Pacific St., Brooklyn, N. Y.
National Gauge and Equipment Company, La Crosse, Wis.
Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.
Taylor Instrument Companies, Rochester, N. Y.
Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

GAUGES, Recording

C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.

GAUGES, Safety

Griebel Instrument Co., Carbondale, Pa.
The Wm. Powell Co., Cincinnati, Ohio.

GAUGES, Siphon Pressure

National Gauge Company, 300 Pacific St., Brooklyn, N. Y.

GAUGES, "U"

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
The Hays Corporation, 1042 East Eighth St., Michigan City, Indiana.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
The Meriam Co.. 8405 Detroit Ave., Cleveland, Ohio.
Metric Metal Works, Erie, Pa.
National Gauge Company, 300 Pacific St., Brooklyn, N. Y.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
Provident Engineering Co., 39 Cortlandt St., New York, N. Y.
The Refinery Supply Company, Tulsa, Oklahoma.
Taylor Instrument Companies, Rochester, N. Y.

GAUGES, Vacuum Recording

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Metric Metal Works, Erie, Pa.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.
Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

GAUGES, Vacuum Pressure Recording

Crosby Steam Gauge and Valve Co., 10 Rowland St., Boston, Mass.

GAUGES, Water

A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Griebel Instrument Co., Carbondale, Pa.
Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.
The Wm. Powell Co., Cincinnati, Ohio.
The Williams Gauge Co., 1620 Pennsylvania Ave., N. S., Pittsburgh, Pa.

GAUGES, Water Level

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.

GAUGE GLASSES

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.
Carl H. Wagner & Sons, 1944 W. Albany Ave., Chicago, Ill.

GEARS

The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
De Laval Steam Turbine Co., Trenton, N. J.
The Falk Corporation, Milwaukee, Wisconsin.
General Electric Co., Schenectady, New York.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.
Houston Armature Works, Houston, Texas.
Union Engineering Co., Cleveland, Ohio.

GEARS, Reduction

De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
The Falk Corporation, Milwaukee, Wisconsin.
Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Houston Armature Works, Houston, Texas.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Union Engineering Co., Cleveland, Ohio.

GENERATING SETS, Electric

The Louis Allis Co., 123-133 Stewart St., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady, New York.
Houston Armature Works, Houston, Texas.
Roth Brothers & Co., 1400 W. Adams St., Chicago, Ill.
B. A. Wesche Electric Co., 1628 Vine Street, Cincinnati, Ohio.

GENERATORS, Ammonia Gas

Henry Vogt Machine Co., Louisville, Ky.

GENERATORS, D. C. & A. C.

Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady, New York.
Houston Armature Works, Houston, Texas.
B. A. Wesche Electric Co., 1628 Vine Street, Cincinnati, Ohio.

GENERATORS, Gas Linings

BERNITZ FURNACE APPLIANCE CO., 80 FEDERAL ST., BOSTON, MASS.
"Long-life, Clinker-proof" Super Linings that increase capacities and operating efficiencies.

GENERATORS, Turbo

Coppus Engineering Corporation, Worcester, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady, New York.
Houston Armature Works, Houston, Texas.

GENERATORS, Welding

General Electric Co., Schenectady, New York.
Houston Armature Works, Houston, Texas.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Magnolia Gas Products Co., Houston, Texas.
Oxweld Acetylene Company, 30 East 42nd St., New York, N. Y.
Smith Welding Equipment Corporation, 2619-33 Fourth St., S. E., Minneapolis, Minn.

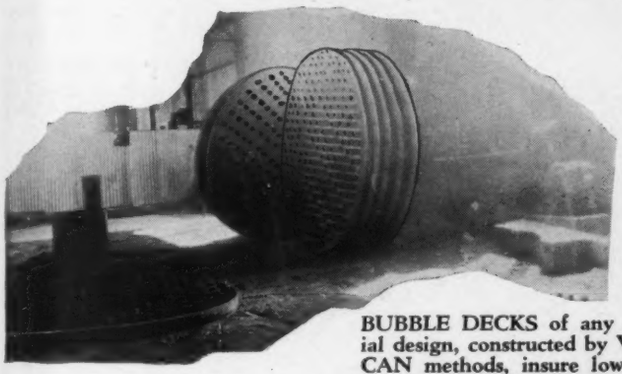
GLASSWARE, Calibrated

Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.

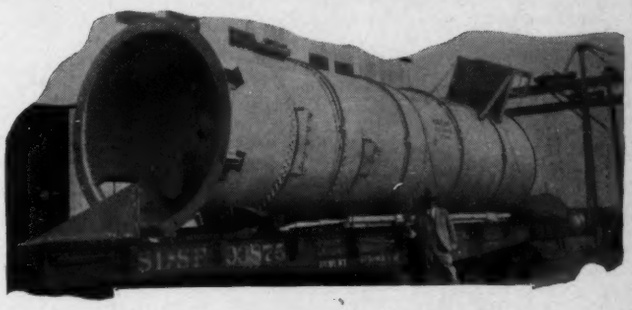
VULCAN STEEL TANK CORP. TULSA, OKLA.

VULCAN

ENGINEERS & MFGRS. of LIGHT & HEAVY STEEL PLATE WORK

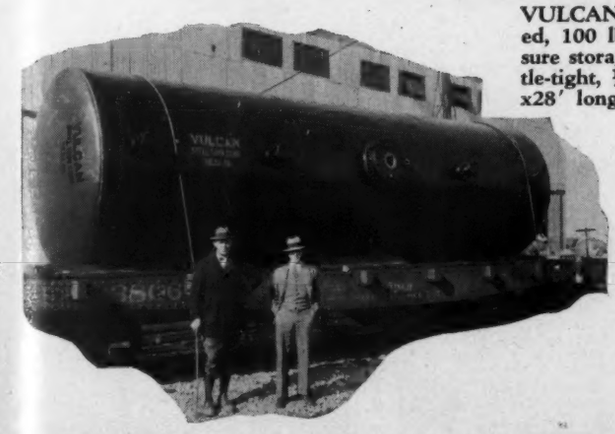


BUBBLE DECKS of any special design, constructed by VULCAN methods, insure low cost and 100% efficiency.

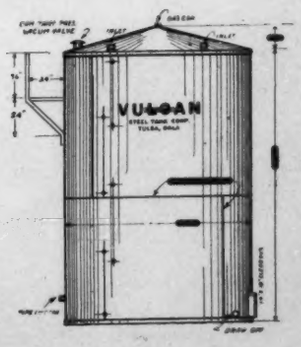


TOWERS of all descriptions, VULCAN super-welded, riveted and welded or all riveted construction.

THE VULCAN PLANT is newly built and equipped with special machinery to meet the requirements of the modern oil and gasoline refining trade for stills, towers, pressure vessels and other lines of heavy steel plate construction.



VULCAN super-welded, 100 lb. acid pressure storage tank, bottle-tight, ½"x8′ diam. x28′ long.



VULCAN double-welded, vertical and horizontal storage tanks, for all purposes.

VULCAN STEEL TANK CORP., Tulsa, Okla.

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GOGGLES
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Magnolia Gas Products Co., Houston, Texas.
Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.
Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y.

GOVERNORS, Boiler Feed
The Chaplin-Fulton Co., 28 Penn Ave., Pittsburgh, Pa.
Fisher Governor Co., Marshalltown, Iowa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
Wilbraham Green Blowers Co., Pottstown, Pa.

GOVERNORS, Engine
Bessemer Gas Engine Company, Grove City, Pa.
Godfrey, Keeler Co., 70 Warren St., New York, N. Y.
Judson Governor Co., Rochester, N. Y.

GOVERNORS, Gas
The Chaplin-Fulton Co., 28 Penn Ave., Pittsburgh, Pa.
Fisher Governor Co., Marshalltown, Iowa.
Judson Governor Co., Rochester, N. Y.
Mueller Co., Decatur, Ill.
Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

GOVERNORS, Gas Fuel Boiler
Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.

GOVERNORS, Pump
George B. Allan & Co., Simpson Building, Dallas, Texas.
Atlas Valve Co., 282-286 South St., Newark, N. J.
A. W. Cash Co., Box 135, Decatur, Ill.
Jarecki Manufacturing Co., St. Louis, Mo.
Leslie Company, Lyndhurst, N. J.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
Mueller Co., Decatur, Ill.
Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.
Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.
The Williams Gauge Co., 1620 Pennsylvania Ave., N. S., Pittsburgh, Pa.

GRAPHITE, Boiler
Detroit Graphite Company, Detroit, Mich.
Fisher Governor Co., Marshalltown, Iowa.

GRATES
Barnhart-Davis Co., Warren, Pa
Godfrey, Keeler Co., 70 Warren St., New York, N. Y.

GRATINGS, Area
Kerlow Steel Flooring Company, 218-222 Culver Ave., Jersey City, N. J.

GRATINGS, Steel, Open
Kerlow Steel Flooring Company, 218-222 Culver Ave., Jersey City, N. J.

GREASES, Industrial
Sun Oil Company, Tulsa, Oklahoma.

GRINDERS
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

GRINDERS, Electric
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Jas. Clark, Jr., Electric Co., 600 E. Bargman St., Louisville, Ky.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

GRINDERS, Pneumatic
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

GUARDS, Machinery
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

H

HACKSAWS, Electric
Jas. Clark, Jr., Electric Co., 600 E. Bargman St., Louisville, Ky.

Hammers, Forging
NAZEL ENGINEERING & MARINE WKS., 4041 N. FIFTH ST., PHILADELPHIA, PA.
The NAZEL AIR HAMMER is a self-contained unit, hammer and compressor combined. It is built in three types; six sizes for belt or geared motor drive with capacities up to 7" square for all kind of forgings used in the reducing and refining of petroleum.

HAMMERS, Pneumatic
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Dayton Pneumatic Tool Corp., 408 Ray St., Dayton, Ohio.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

HAMMERS, Pneumatic Chipping and Calking
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Dayton Pneumatic Tool Corp., 408 Ray St., Dayton, Ohio.
Ingersoll-Rand Co., 11 Broadway New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

HANGERS, Shaft
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue. Cleveland, Ohio.

HARDWARE
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

HEADS, Condenser
Barnhart-Davis Co., Warren, Pa
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Elliott Co., Jeannette, Pa.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

HEADS, Exhaust
Burt Manufacturing Company, 929 S. High, Akron, Ohio.
Fisher Governor Co., Marshalltown, Iowa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

HEADS, Flanged and dished
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City. Mo.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

HEADS, Tank
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
The Petroleum Iron Works Co., Sharon, Pa.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

HEADS, Welded
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

HEADERS
American Radiator Co., 816 S. Michigan Ave., Chicago, Ill.
Pittsburgh Pipe & Coil Bending Co., Pittsburgh, Pa.
Seamless Steel Equipment Corp., 39 Broadway, New York, N. Y.
Henry Vogt Machine Co., Louisville, Ky.

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M. W. Kellogg Co., 7 Day St., New York, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
The Petroleum Iron Works Co., Sharon, Pa.
Pittsburgh Pipe & Coil Bending Co., Pittsburgh, Pa.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Wyatt Metal & Boiler Works, Dallas, Texas.
Henry Vogt Machine Co., Louisville, Ky.

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C. F. Braun & Co., Alhambra, California.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
The Calorizing Co., Pittsburgh, Pa.
J. A. Campbell, P. O. Box 669, Long Beach, Calif.
Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
Hope Engineering & Supply Co., Mt. Vernon, Ohio.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
C. H. Leach Co., 255 Broadway Ave., New York, N. Y.
Newton Process Mfg. Co., Fullerton, Calif.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Struthers-Wells Co., Warren, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Titusville Iron Works Co., Titusville, Pa.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.
Wyatt Metal & Boiler Works, Dallas, Texas.

HEATERS, Air
The Air Preheater Corp., 25 Broadway, New York, N. Y.
Badenhausen Corporation, 900 Victory, Bldg., Philadelphia, Pa.
The Calorizing Co., Pittsburgh, Pa.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
Maxon Premix Burner Co., Muncie, Ind.

HEATERS, Electric
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
General Electric Co., Schenectady, New York.

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Elliott Co., Jeannette, Pa.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

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Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

HEATERS, Feed Water Open
Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.
Elliott Co., Jeannette, Pa.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

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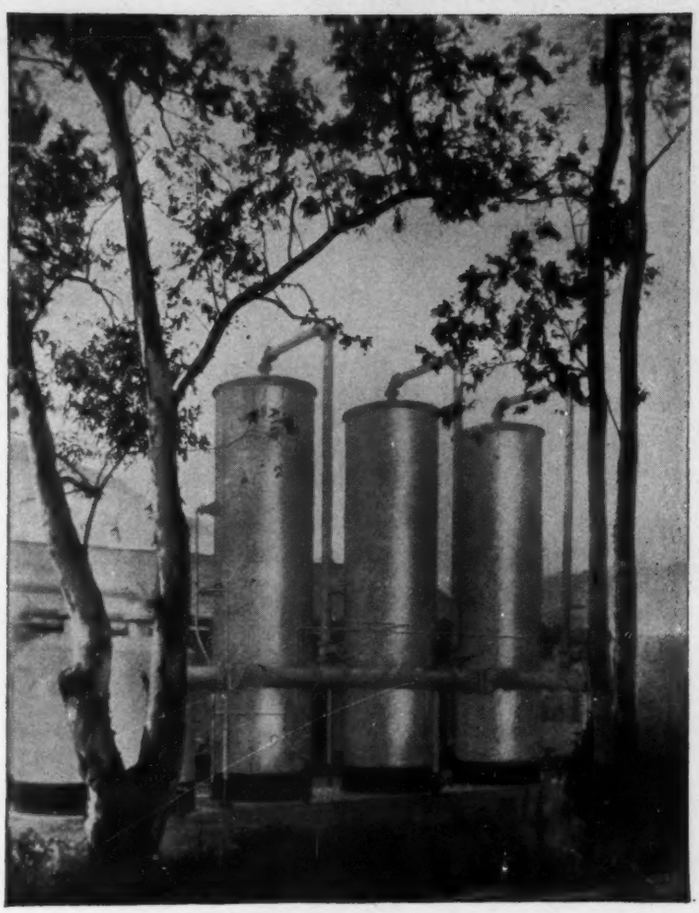

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Ehret Magnesia Manufacturing Co., Valley Forge, Pa.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

York Ice Machinery Corporation, 2201 Texas Avenue, Houston, Texas.

INSULATING MATERIALS, Heat

Armstrong Cork & Insulation Co., 24th St. & Allegheny River, Pittsburgh, Pa.

R. V. Aycock Company, Kansas City, Mo.

Banner Rock Products Co., Alexandria, Indiana.

The Philip Carey Mfg. Co., Lockland, Ohio.

Ehret Magnesia Manufacturing Co., Valley Forge, Pa.

Insulating Products Company, 1553 West Madison St., Chicago, Ill.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

King Refractories Co., Inc., 1715 Niagara St., Buffalo, N. Y.

Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

U. S. Mineral Wool Co., 280 Madison Ave., New York, N. Y.

INSULATING MATERIAL, Rock Wood

Banner Rock Products Co., Alexandria, Indiana.

INSULATION, Boiler

Armstrong Cork & Insulation Co., 24th St. & Allegheny River, Pittsburgh, Pa.

R. V. Aycock Company, Kansas City, Mo.

Banner Rock Products Co., Alexandria, Indiana.

The Philip Carey Mfg. Co., Lockland, Ohio.

Ehret Magnesia Manufacturing Co., Valley Forge, Pa.

Insulating Products Company, 1553 West Madison St., Chicago, Ill.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

Keasbey & Mattison Co., Ambler, Pa.

King Refractories Co., Inc., 1715 Niagara St., Buffalo, N. Y.

INSULATION, Cork

Armstrong Cork & Insulation Co., 24th St. & Allegheny River, Pittsburgh, Pa.

INSULATION, Corkboard

Armstrong Cork & Insulation Co., 24th St. & Allegheny River, Pittsburgh, Pa.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.

L. Mundet & Son, Inc., 461 8th Ave., New York, N. Y.

INSULATION, Roof, Cork

L. Mundet & Son, Inc., 461 8th Ave., New York, N. Y.

INSULATION, Tank

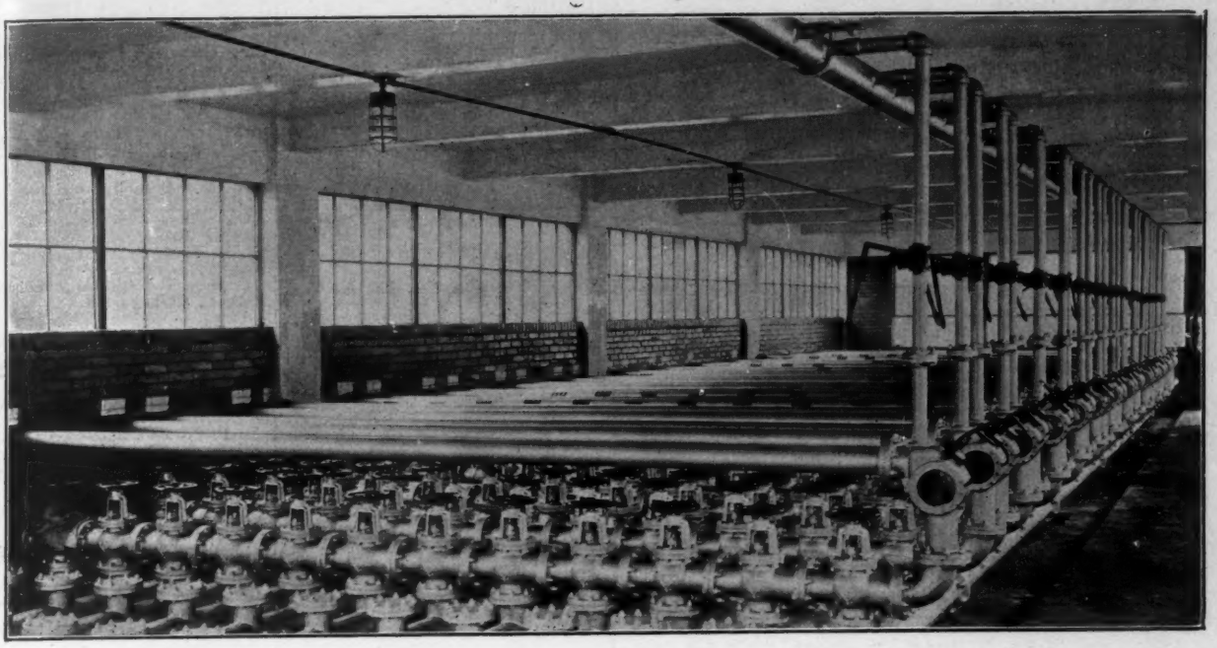
THE CELOTEX CO., 645 N. MICHIGAN AVE., CHICAGO, ILL.
Celotex Industrial Insulation for vapor-tight woods roofs, for steel roofs, for tank jacketing, and for many allied uses in production and refinery insulation has been successfully standardized. Full details of design and construction are available in a Celotex publication, "Assembled Data on Tank Insulation."

INSULATION, Tank Car

Armstrong Cork & Insulation Co., 24th St. & Allegheny River, Pittsburgh, Pa.

Banner Rock Products Co., Alexandria, Indiana.

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.



An installation of twenty-seven Reid Fulton Type Boxes in the refinery of the Pennzoil Company, Oil City, Pennsylvania

THE FULTON TYPE RECEIVING BOX

The installation view above shows the compactness of the box, one feature of the design. Another feature is the oil pocket from which samples of oil passing through the box may be taken without opening the box.

For a complete description of this box, and other refinery equipment, write for descriptive Bulletin No. 38.

Side View—Fulton Type Receiving Box

JOSEPH REID GAS ENGINE COMPANY
OIL CITY, PENNSYLVANIA, U. S. A.

Mid-Continent Representative: Frick-Reid Supply Co., Tulsa, Okla.
Export Representative: Oil Field Equipment Co., Inc., 30 Church Street, New York City, U. S. A.

REID REFINERY EQUIPMENT

INSULATION, Wax Equipment

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Celotex Industrial Insulation for wax chilling coils, for wax tanks, and for chilling rooms is available. Special designs are furnished on request.

INTERCHANGERS, Heat

Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Struthers-Wells Co., Warren, Pa.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

INTERCOOLERS

Bessemer Gas Engine Company, Grove City, Pa.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Pennsylvania Pump and Compressor Co., Easton, Pa.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

IRON, Bar

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Reading Iron Company, Reading, Pa.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

IRON, Channel

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

IRON, Corrugated

AMERICAN ROLLING MILL CO., MIDDLETOWN, OHIO.
Twenty years' satisfactory service has given ARMCO Ingot Iron a reputation for durability well known among the manufacturing industries.
Braden Steel Corporation, 3 No. Madison, Tulsa, Okla.
Industrial Construction Co., 305 Central National Bank Bldg., Tulsa, Okla.

IRON, Galvanized

AMERICAN ROLLING MILL CO., MIDDLETOWN, OHIO.
ARMCO Ingot Iron is especially adaptable to the most severe sheet metal service requirements. It has the purest possible iron base, and the finest grade of tightly adherent zinc coating.

IRON, Rolled

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.

IRON, Sheet

AMERICAN ROLLING MILL CO., MIDDLETOWN, OHIO.
Twenty years' satisfactory service has given ARMCO Ingot Iron a reputation for durability well known among manufacturing industries.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

IRON, Stainless

The Calorizing Co., Pittsburgh, Pa.

IRONS, Stay Bolt

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Reading Iron Company, Reading, Pa.

J

JACKS, Hydraulic

A. L. Henderer's Sons, Maryland Ave. and Beech St., Wilmington, Delaware.

JACKS, Pump

Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.

JARS, Hydrometer

W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.
The Refinery Supply Company, Tulsa, Oklahoma.
Taylor Instrument Companies, Rochester, N. Y.

JOINTS, Expansion

American District Steam Company, North Tonawanda, N. Y.
ADSCO. Expansion Joints especially designed for Oil Service, High and Low Pressure Steam and Hot Water Piping. Send for Catalog 201—Reference data on Expansion in Pipe Lines.
Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.
H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
The Philip Carey Mfg. Co., Lockland, Ohio.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

JOINTS, Flexible Ball

Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.

JOINTS, Midwest Pipe

Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.

JOINTS, Swing

Atlas Valve Co., 282-286 South St., Newark, N. J.
Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.
H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

K

KETTLES, Steam Jacketed

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.
The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
Buffalo Foundry & Machine Co., 1569 Fillmore Ave., Buffalo, N. Y.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Mixing Equipment Co., Inc., 229 East 38th St., New York, N. Y.
The Petroleum Iron Works Co., Sharon, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Sowers Manufacturing Co., 1305 Magra St., Buffalo, N. Y.
Struthers-Wells Co., Warren, Pa.
Union Engineering Co., Cleveland, Ohio.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

KETTLES, Plain or Mixing

National Electric Heating Company, 420 Lexington Ave., New York, N. Y.

KETTLES, Tar and Asphalt

The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.

L

LABORATORY, Apparatus

Wm. Ainsworth & Sons, 2151 Lawrence St., Denver, Colo.
Frank S. Betz Co., Hammond, Ind.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Gray Instrument Co., 64-70, West Johnson St., Germantown, Philadelphia, Pa.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.
Mueller Co., Decatur, Ill.
NATIONAL METER CO., 299 BROADWAY, NEW YORK, N. Y.
EMPIRE oscillating Piston Meters for water, oils and other liquids. Accurate, efficient and durable. Send for circular.
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The Refinery Supply Company, Tulsa, Oklahoma.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

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Frank S. Betz Co., Hammond, Ind.
W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Taylor Instrument Companies, Rochester, N. Y.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

LACQUERS, all purposes

Pittsburgh Plate Glass Co., Milwaukee, Wis.

LAMPS, Edison Electric Safety Cap

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

LAMPS, Hand

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

LEATHER, Hydraulic

Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
E. F. Houghton & Company, Philadelphia, Pa.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.

LEATHER, Lace

Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
E. F. Houghton & Company, Philadelphia, Pa.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.

LEATHER, Pump

Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
The Chicago Rawhide Mfg. Co., 1267 Elston Ave., Chicago, Ill.
E. F. Houghton & Company, Philadelphia, Pa.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Moloney Belting Co., 1291 Elston Ave., Chicago, Ill.

LEVELS, Precision Machinists

Gray Instrument Co., 64-70, West Johnson St., Germantown, Philadelphia, Pa.

LIDS, Journal Box

Carnes Equipment Company, Box 595, Sand Springs, Oklahoma.

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BENJAMIN ELECTRIC MFG. CO., 120-128 S. SANGAMON ST., CHICAGO, ILL.
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Benjamin Industrial Lighting Equipment, particularly adapted to the needs of the refiner and natural gasoline manufacturer include Heavy Duty Gas and Vapor Proof Lighting Fixtures, for installation in refineries, pump houses, oil fields, yards and terminals; Elliptical Angle Reflectors for yards, terminals and the flood-lighting of filling stations, and Sign Lighting Reflectors for lighting of roof and wall signs and for lighting signs and bulletins at filling stations.
General Electric Co., Schenectady, New York.

LIGHTS, Flood

General Electric Co., Schenectady, New York.

LINING, Flue

American Chimney Corporation, 147 Fourth Ave., New York, N. Y.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Laclede Christy Clay Prod. Co., 1711 Ambassador Bldg., St. Louis, Mo.

LININGS, Furnace

American Chimney Corporation, 147 Fourth Ave., New York, N. Y.
Bernitz Furnace Appliance Co., 80 Federal Street, Boston, Mass.
Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.

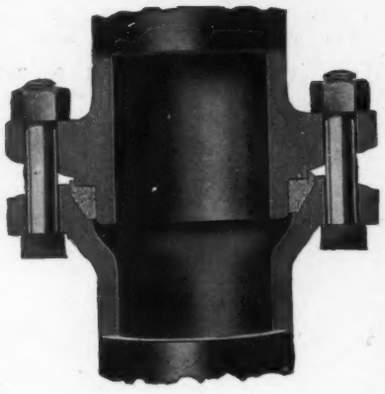
LUBRICANT, Merco

Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.

greater salvage value with cast iron pipe

SALVAGE VALUE

means a lot in gas and oil fields!



Simplex Prepared Joint Piping

COST of piping is a big element in the expense of operating gas, oil, or vapor lines. And often the duration of the field is uncertain.

That's why salvage value is an important element to consider when selecting pipe for your line. Engineers in the Southwest have been able to save money in many cases by taking up old piping and re-laying it in new lines.

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It's easy to lay, too. The Prepared Joint, shown here, has only two bolts, and a thick, endless, ring gasket. Inexperienced men can handle it rapidly and safely.

AMERICAN CAST IRON PIPE COMPANY
BIRMINGHAM, ALABAMA
DISTRICT OFFICES IN PRINCIPAL CITIES

greater salvage value with cast iron pipe

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Multi-feed automatic lubricators for all vertical shaft centrifugal pumps, either new or in service. Oil supplied only when pumps are running.

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Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.

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The Wm. Powell Co., Cincinnati, Ohio.

LUGS, Boiler
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

LUMBER, Asbestos
Keasbey & Mattison Co., Ambler, Pa.

M

MACHINES, Boiler Cap Cleaning
The Roto Company, Sussex Ave. & Newark St., Newark, N. J.

MACHINES, Bolt Threading
Greenfield Tap & Die Corporation, Greenfield, Mass.

MACHINES, Milling
Landis Machine Co., Inc., Waynesboro, Pa.

MACHINES, Pipe
Jarecki Manufacturing Co., St. Louis, Mo.

MACHINES, Pipe and Nipple Threading
The Armstrong Mfg. Co., 27 Cleveland Place, near Spring St., New York, N. Y.

Greenfield Tap & Die Corporation, Greenfield, Mass.

Landis Machine Co., Inc., Waynesboro, Pa.

MACHINES, Pipe Threading and Cutting
The Aetna-Standard Engineering Co., Youngstown, Ohio.

Landis Machine Co., Inc., Waynesboro, Pa.

MACHINES, Sand Blast
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.

MACHINERY, Asphalt and Tar Saturating
GUYTON & CUMFER MFG. CO., 4441-59 FILLMORE ST., CHICAGO, ILL.

Guyton & Cumfer Mfg. Co., "Guycumbo."

MACHINERY, Can Making
E. W. Bliss Company, Brooklyn, New York.

MACHINERY, Can Making and Sealing
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MACHINERY, Elevating and Conveying
F. W. Gartner Company, Houston, Texas.

Union Engineering Co., Cleveland, Ohio.

MACHINERY, Special
Barnhart-Davis Co., Warren, Pa.

E. W. Bliss Company, Brooklyn, New York.

Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.

The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.

Rosedale Foundry & Machine Co., Columbus and Preble Aves., N. S., Pittsburgh, Pa.

Weimar Engineering Works, Jasper & Westmoreland Sts., Philadelphia, Pa.

MACHINERY, Steel Drum and Barrel
E. W. Bliss Company, Brooklyn, New York.

The Max Ams Machine Co., 101 Park Ave., New York, N. Y.

MACHINERY, Steel Drum and Barrel Workers
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MANHEADS, Roof
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

MAN-HOLES
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.

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Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill.

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Modern Engineering Co., 3411 Pine Blvd., St. Louis, Mo.

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Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.

Modern Engineering Co., 3411 Pine Blvd., St. Louis, Mo.

Smith Welding Equipment Corporation, 2619-33 Fourth St., S. E., Minneapolis, Minn.

MANOMETERS
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J. A. Campbell, P. O. Box 669, Long Beach, Calif.

W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.

The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.

The Refinery Supply Company, Tulsa, Oklahoma.

Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.

Taylor Instrument Companies, Rochester, N. Y.

MANOMETERS, High Line Pressure
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Two types: Special Gland Packed (SGP), tested to 300 lbs. working pressure and Special Steel Header (SSH), tested to 1000 lbs. working pressure.

MANOMETERS, Vacuum
MERIAM CO., 8405 DETROIT AVE., CLEVELAND, OHIO.

The 30-inch Meriam "U", SGP Manometer especially designed for pulling vacuum, with a range of 31 inches or 720 millimeters or 15½ pounds.

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MASKS, Hose
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

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For human beings while working in Ammonia fumes, gases, dust, oil or smoke of any nature.

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Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y.

MASKS, Combination Hose
Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

MASKS, Hose, Special
Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

MASKS, Standard Hose
Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

MASKS, Tank Gaugers
Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

MEASURES, Gasoline
Sexton Can Co., Inc., 31 Cross St., Everett, Mass.

MEASURES, Oil
Sexton Can Co., Inc., 31 Cross St., Everett, Mass.

MERCURY
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

METAL, Sheet
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

The New Jersey Zinc Company, 160 Front Street, New York, N. Y.

Wyatt Metal & Boiler Works, Dallas, Texas.

METAL, Welding
General Electric Co., Schenectady, New York.

Columbia Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

METERS, Air
A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.

Chas. J. Clark Blast Meter Co., Gladbrook, Iowa.

Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.

The Connersville Blower Co., Connersville, Ind.

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

Metric Metal Works, Erie, Pa.

Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.

METERS, Boiler
The Hays Corporation, 1042 East Eighth St., Michigan City, Indiana.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

Provident Engineering Co., 39 Cortlandt St., New York, N. Y.

METERS, Differential Flow
Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.

The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.

Metric Metal Works, Erie, Pa.

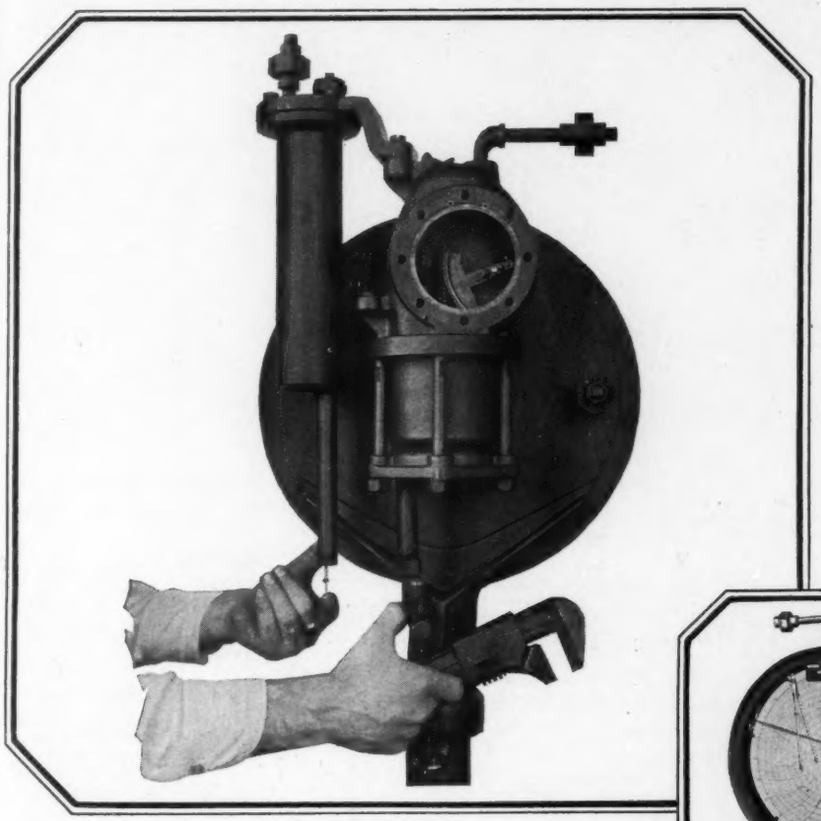
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

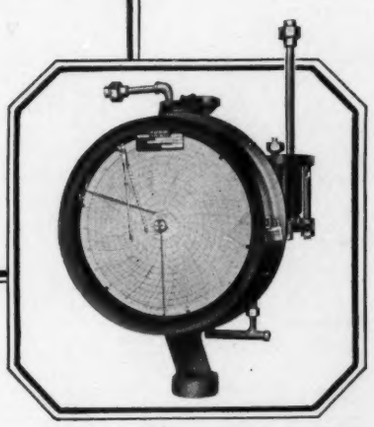
METERS, Electrical
General Electric Co., Schenectady, New York.

Houston Armature Works, Houston, Texas.

EASY . . . *to clean*



The many revolutionary advantages of the new Foxboro Orifice Meter has led to its adoption by oil and gas companies everywhere. It has no inherent error. It has a uniform scale chart. Office corrections for variables are reduced to a minimum. The records by which you buy or sell gas will be accurate, not approximate. It is the most powerful float type meter on the market. All parts are practically indestructible Calibration is permanent.



The illustration shows the removal of "U" bend and rust proof check floats.

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THE man in the field will be quick to appreciate how simple a job it is to clean the new Foxboro Orifice Meters. After cleaning and assembling the meter is zeroed by a simple micrometer adjustment.

Foxboro guarantee sealed to each recording and controlling instrument.

The Foxboro Company

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205 So. Cheyenne Avenue, Tulsa, Okla.

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ROCHESTER, N. Y. ATLANTA LOS ANGELES SAN FRANCISCO
PORTLAND, ORE. DETROIT

FOXBORO

REG. U. S. PAT. OFF.

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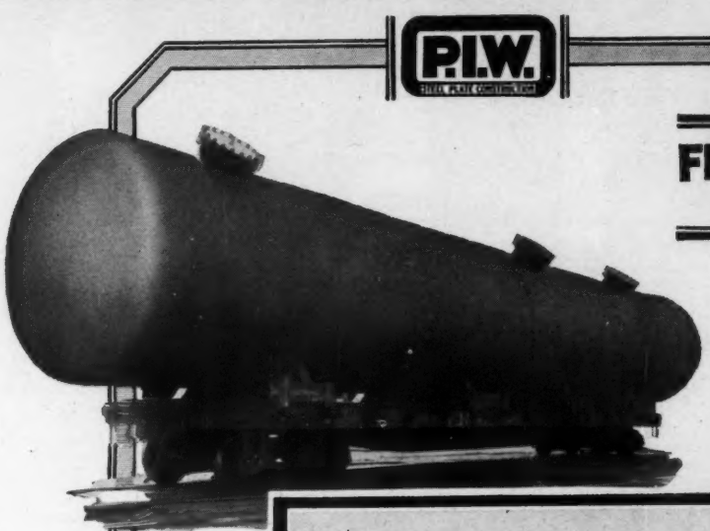

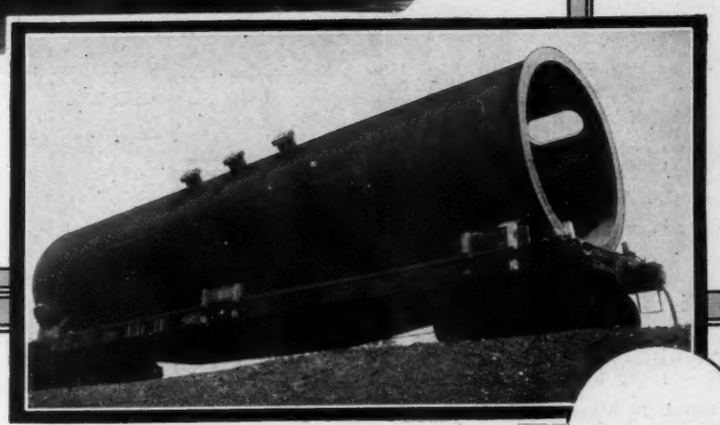

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New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.
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R. V. Aycock Company, Kansas City, Mo.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Garlock Packing Co., Palmyra, N. Y.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.
Voorhees Rubber Mfg. Co., 105 Hudson St., New York, N. Y.

PACKING, Sheet Asbestos

R. V. Aycock Company, Kansas City, Mo.
George B. Allan & Co., Simpson Building, Dallas, Texas.
Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Metallo Gasket Co., 12 to 20 Bethany St., P. O. Box 151, New Brunswick, N. J.

PACKING, Valve

Garlock Packing Co., Palmyra, N. Y.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Metalastic, Incorporated, 70 Montgomery St., Jersey City, N. J.

PACKING, Valve Steam

Cincinnati Gasket & Packing Co., 1507-1511 Elm St., Cincinnati, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Metalastic, Incorporated, 70 Montgomery St., Jersey City, N. J.

PAINTS, Acidproofing

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.

PAINTS, Acid Resisting

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
INTERNATIONAL COMPOSITION CO., 25 BROADWAY, NEW YORK CITY, N. Y. Rubshell Paints for tank bottoms, also for tank roofs, preventing damage by hydrogen sulphide gas.
Pittsburgh Plate Glass Co., Milwaukee, Wis.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

PAINTS, Aluminum

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.
The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Black Hot Surface

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
The Philip Carey Mfg. Co., Lockland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.
Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.

PAINTS, Boiler Wall

The Philip Carey Mfg. Co., Lockland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.
Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.

PAINTS, Concrete

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
International Compositions Co., 25 Broadway, New York, N. Y.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Concrete Waterproofing

The Philip Carey Mfg. Co., Lockland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
International Compositions Co., 25 Broadway, New York, N. Y.
Pittsburgh Plate Glass Co., Milwaukee, Wis.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.

PAINTS, Dampproofing

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
The Philip Carey Mfg. Co., Lockland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
International Compositions Co., 25 Broadway, New York, N. Y.
Pittsburgh Plate Glass Co., Milwaukee, Wis.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.

PAINTS, Drum

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Enamels

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Galvanized Iron

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.

PAINTS, High Temperature

Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
International Compositions Co., 25 Broadway, New York, N. Y.
King Refractories Co., Inc., 1715 Niagara St., Buffalo, N. Y.

PAINT, Graphite

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINT, Machinery

Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Oilproofing

Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
International Compositions Co., 25 Broadway, New York, N. Y.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Pipe Line

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
The Philip Carey Mfg. Co., Lockland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
International Compositions Co., 25 Broadway, New York, N. Y.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Pittsburgh Plate Glass Co., Milwaukee, Wis.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Rathbun Company, Inc., 212 West Overland Street, El Paso, Texas.

PAINTS, Powder

Detroit Graphite Company, Detroit, Mich.

PAINTS, Pump

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINT, Red Lead

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Roofing

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
The Philip Carey Mfg. Co., Lockland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Pittsburgh Plate Glass Co., Milwaukee, Wis.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

PAINTS, Steel

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
International Compositions Co., 25 Broadway, New York, N. Y.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Steel Preservative

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
International Compositions Co., 25 Broadway, New York, N. Y.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.
Reiter Company, 259 North St., Elgin, Ill.

PAINT, Tanks

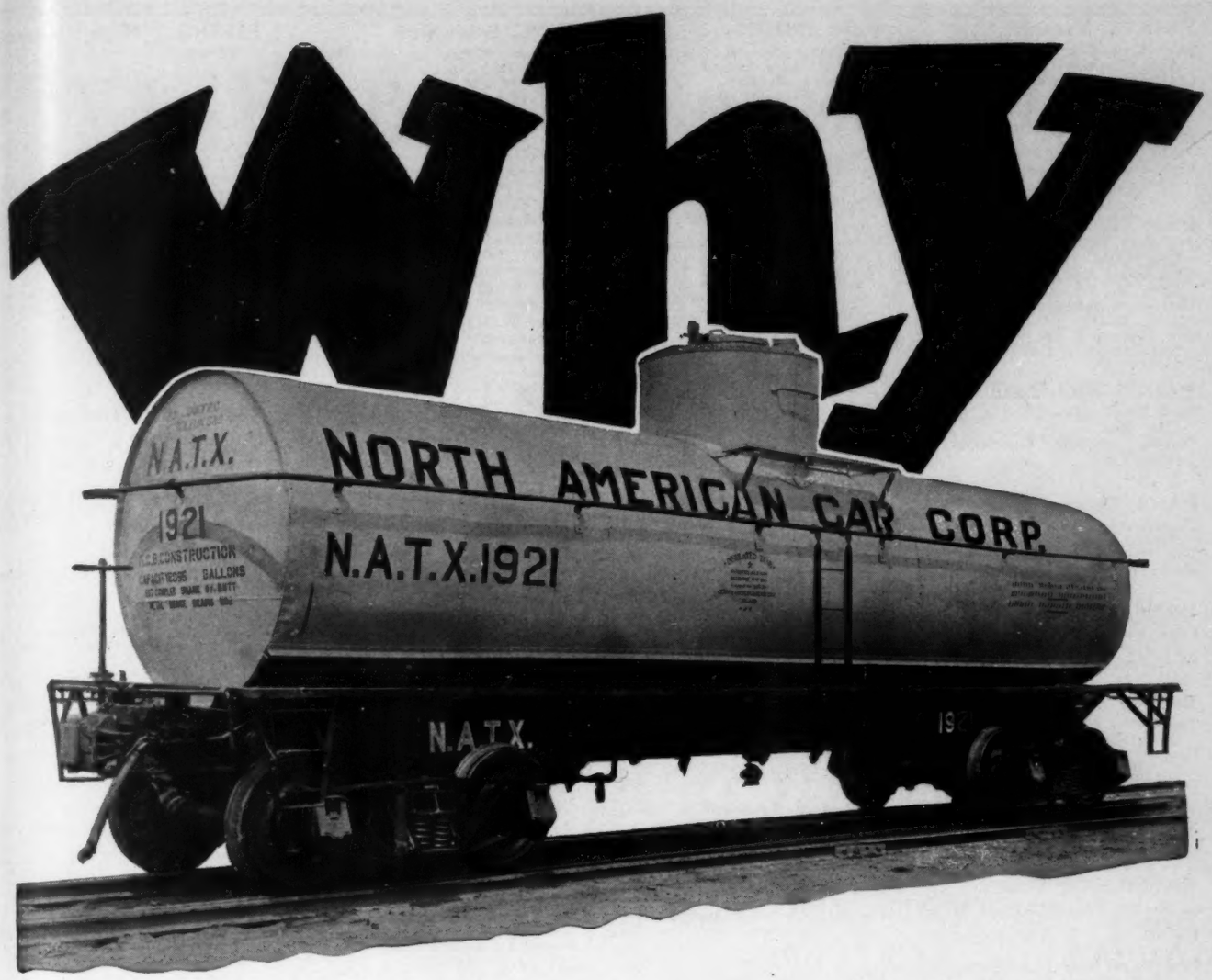
The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
International Compositions Co., 25 Broadway, New York, N. Y.
Pittsburgh Plate Glass Co., Milwaukee, Wis.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

PAINT, Tank Car

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
International Compositions Co., 25 Broadway, New York, N. Y.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Tank Car Interior

The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
International Compositions Co., 25 Broadway, New York, N. Y.



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The Arco Company, 6408 Euclid Ave., Cleveland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.
Pittsburgh Plate Glass Co., Milwaukee, Wis.

PAINTS, Weatherproofing

The Philip Carey Mfg. Co., Lockland, Ohio.
Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.
Hill, Hubbell & Co., 115 Davis St., San Francisco, California.

PAINT, White Lead

Cook Paint & Varnish Co., Kansas City, Mo.
Detroit Graphite Company, Detroit, Mich.

PANS, Dephlegmator

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
The Petroleum Iron Works Co., Sharon, Pa.

PANS, Sweating

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Struthers-Wells Co., Warren, Pa.

PAPER, Asbestos

The Philip Carey Mfg. Co., Lockland, Ohio.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.

PAPER, Blue Print

A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
Kolesch & Co., 138 Fulton St., New York, N. Y.
New York Blue Print Paper Co., 96-102 Reade St., New York, N. Y.
U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

PAPER, Drawing and Tracing

A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Kolesch & Co., 138 Fulton St., New York, N. Y.
New York Blue Print Paper Co., 96-102 Reade St., New York, N. Y.
U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

PAPER, Filter

W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
Palo Company, 153 West 23rd St., New York, N. Y.
The Refinery Supply Company, Tulsa, Oklahoma.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

PETROLEUM TESTING APPARATUS

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.
The Refinery Supply Company, Tulsa, Oklahoma.
Taylor Instrument Companies, Rochester, N. Y.

PIPE BENDS

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.
Pittsburgh Pipe & Coil Bending Co., Pittsburgh, Pa.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Roessing Manufacturing Company, Sharpsburg Sta., Pittsburgh, Pa.
Vulcan Steam Forging Co., 247 Rano St., Buffalo, N. Y.

PIPE COVERING MATERIALS

Armstrong Cork & Insulation Co., 24th St. & Allegheny River, Pittsburgh, Pa.
BANNER ROCK PRODUCTS CO., ALEXANDRIA, IND.
The BANNER ROCK PRODUCTS COMPANY, in addition to standard styles, makes a special metal covered pipe covering that is quickly removable and replaceable. This style No. 65 is a popular, efficient and economical covering for refineries.
The Philip Carey Mfg. Co., Lockland, Ohio.
Ehret Magnesia Manufacturing Co., Valley Forge, Pa.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

PIPE

National Electric Heating Company, 420 Lexington Ave., New York, N. Y.

PIPE, Acid Resisting

The Duriron Company, Inc., Dayton, Ohio.

PIPE, Acid-proof Stoneware

The U. S. Stoneware Co., 50 Church St., New York, N. Y.

PIPE, Aluminum

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.

PIPE, Armco Ingot Iron

AMERICAN ROLLING MILL CO., MIDDLETOWN, OHIO.
ARMCO Ingot Iron pipe is manufactured by the electric arc butt-welded or the spiral method, electric arc butt-welded. ARMCO Ingot Iron was invented and designed to resist atmospheric, underground, underwater and chemical corrosion.

PIPE, Cast Iron

American Cast Iron Pipe Co., P. O. Box 151-152, Birmingham, Alabama.
American Radiator Co., 816 S. Michigan Ave., Chicago, Ill.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

PIPE, Culvert

Wyatt Metal & Boiler Works, Dallas, Texas.

PIPE, Electric Arc Butt-Welded

AMERICAN ROLLING MILL CO., MIDDLETOWN, OHIO.
Made from ARMCO Ingot Iron.
Diameters, 10" to 60".
Gauges No. 12 to ¼" plates.
Lengths, 5' to 40'.
Field Joints — Coupler flange, Slip joint, Field welded.

PIPE, Fabricated

Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Roessing Manufacturing Company, Sharpsburg Sta., Pittsburgh, Pa.
Struthers-Wells Co., Warren, Pa.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

PIPE, Gas

Jarecki Manufacturing Co., St. Louis, Mo.
Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
The Petroleum Iron Works Co., Sharon, Pa.
Pittsburgh Steel Products Co., Union Arcade Bldg., Pittsburgh, Pa.
Reading Iron Company, Reading, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.

PIPE, Galvanized Culvert

Wyatt Metal & Boiler Works, Dallas, Texas.

PIPE, Riveted

The Biggs Boiler Works Company, Akron, Ohio.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Coatesville Boiler Works, Coatesville, Pa.
Connery & Co., Inc., Second & Luzerne Sts., Philadelphia, Pa.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
Struthers-Wells Co., Warren, Pa.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

PIPE, Seamless Brass

Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
National Tube Co., Frick Bldg., Pittsbugrh, Pa.

PIPE, Seamless Steel

The Babcock & Wilcox Tube Co., 85 Liberty St., New York, N. Y.
Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Pittsburgh Steel Products Co., Union Arcade Bldg., Pittsburgh, Pa.

PIPE, Spiral, Electric Arc, Butt-Welded

AMERICAN ROLLING MILL CO., MIDDLETOWN, OHIO.
Made from ARMCO Ingot Iron.
Diameters, 8" to 24".
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Lengths, 5' to 40'.
Field Joints — Coupler, Flange, Slip joint, Field welded.

PIPE, Steam Jacketed

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Roessing Mfg. Co., Sharpsburg Sta., Pittsburgh, Pa.

PIPE STEEL

National Tube Co., Frick Bldg., Pittsbugrh, Pa.

PIPE, Wrought Iron

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Reading Iron Company, Reading, Pa.

PIPING, High pressure Steam

The Babcock & Wilcox Tube Co., 85 Liberty St., New York, N. Y.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
Pittsburgh Steel Products Co., Union Arcade Bldg., Pittsburgh, Pa.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Roessing Manufacturing Company, Sharpsburg Sta., Pittsburgh, Pa.
Seamless Steel Equipment Corp., 39 Broadway, New York, N. Y.
A. O. Smith Corporation, Milwaukee, Wisconsin.

PIPING, Installation

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Roessing Manufacturing Company, Sharpsburg Sta., Pittsburgh, Pa.

PIPING, Power

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.
Midwest Piping & Supply Co., 1452 S. Second St., St. Louis, Mo.
Pittsburgh Steel Products Co., Union Arcade Bldg., Pittsburgh, Pa.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Roessing Manufacturing Company, Sharpsburg Sta., Pittsburgh, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.

PIPING, Water

Mueller Co., Decatur, Ill.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Roessing Manufacturing Company, Sharpsburg Sta., Pittsburgh, Pa.

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Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

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Bessemer Gas Engine Company, Grove City, Pa.
C. F. Braun & Co., Alhambra, California.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Fluor Construction Co., 909 E. 59th St., Los Angeles, California.
Jackson Engineering & Equipment Co., 909 E. 59th St., Los Angeles, California.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

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E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
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The Walter E. Lummus Co., 173 Milk St., Boston, Mass.

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Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

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The Meriam Co.. 8405 Detroit Ave., Cleveland, Ohio.

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Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Cyclops Steel Co., Titusville, Pa.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
Wyatt Metal & Boiler Works, Dallas, Texas.

PLUGS, Automatic Tar

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

PLUGS, Bull

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Pennsylvania Forge Company, Philadelphia, Pa.

PLUGS, Fusible

Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.
The Wm. Powell Co., Cincinnati, Ohio.

PLUGS, Still

Cyclops Steel Co., Titusville, Pa.
Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.
OHIO STEEL FOUNDRY CO., SPRINGFIELD, OHIO.
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Pennsylvania Forge Company, Philadelphia, Pa.
Henry Vogt Machine Co., Louisville, Ky.

PLUGS, Monel Metal Still

Equitable Equipment Company, Inc., 410 Camp St., New Orleans, La.

PLUGS, Tar

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

POLES, Gauge

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

POLES, Steel

Truscon Steel Co., Youngstown, Ohio.

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Blaw-Knox Co., Pittsburgh, Pa.
C. F. Braun & Co., Alhambra, California.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
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B. P. Lientz & Co., 3409 East 18th St., Kansas City, Mo.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Newton Process Mfg. Co., Fullerton, Calif.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Struthers-Wells Co., Warren, Pa.

PREHEATING, Torches

HAUCK MANUFACTURING CO., 126-134 TENTH ST., BROOKLYN, N. Y.
Blow—Steel Tank—made in 15 different sizes for burning kerosene, gasolene and fuel oil; also made in safety suction types, approved by Underwriters' Laboratory.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.
National Oxygen Co., 29 S. LaSalle St., Chicago, Ill.
Oxweld Acetylene Company, 30 East 42nd St., New York, N. Y.
Smith Welding Equipment Corporation, 2619-33 Fourth St., S. E., Minneapolis, Minn.
Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill.

PRESERVATIVE, Rope

Cling-Surface Company, 1032-1048 Niagara Street, Buffalo, N. Y.

PRESERVATIVE, Wire Rope

Cling-Surface Company, 1032-1048 Niagara Street, Buffalo, N. Y.

PREVENTIVES, Rust, Temporary

Oakite Products, Inc., 22 Thames St., New York, N. Y.

PROCESS, Lubricating Oil

Graver Corporation, East Chicago, Ind.

PROTECTION APPARATUS,

Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill.

PSYCHROMETERS

Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.

PULLERS

John Waldron Corporation, New Brunswick, N. J.

PULLEYS

The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Houston Armature Works, Houston, Texas.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

PULLEYS, Clutch

Bessemer Gas Engine Company, Grove City, Pa.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Union Engineering Co., Cleveland, Ohio.

PULVERIZERS

Erie City Iron Works, Erie City, Pa.

PUMP RODS, Monel Metal

Equitable Equipment Company, Inc., 410 Camp St., New Orleans, La.

PUMPS

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Dean Hill Pump Co., Anderson, Ind.
The Deming Co., Salem, Ohio.
Economy Pumping Machinery Co., 3431 W. 48th Place, Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Luitwieler Pumping Engine Co., 123 Ames St., Rochester, N. Y.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
Southern Engine & Pump Co., 615 Washington Ave., Houston, Tex.
Wagener Steam Pump Co., Canton, Ohio.
Waterous Co., St. Paul, Minn.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.
WESTCO-CHIPPEWA PUMP CO., INC., DAVENPORT, IA.
Westco Pumps are generally regarded among the refineries as standard for pumping reflux over bubble towers.
Westco are recognized by the leading engineers of the country as the best pumps for small capacities (5 to 200 G.P.M.) for operation against leads up to 150 lbs. pressure which is accomplished in single stage construction operating 1725 R.P.M.
Westco features—Double Suction—Absence of end thrust—no metal to metal contact—high efficiency—high pressure single stage—low first cost—small space — accessibility—direct connected to motor, turbine or gasoline engine—ball bearing.
Westco Pumps require less metal therefore can be built of special alloys to resist corrosive action of acids and other liquids at reasonable prices.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Acid

Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Titusville Iron Works Co., Titusville, Pa.
Union Engineering Co., Cleveland, Ohio.
Wagener Steam Pump Co., Canton, Ohio.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Acid Resisting

The Duriron Company, Inc., Dayton, Ohio.

PUMPS, Air

American Steam Pump Company, Battle Creek, Michigan.
Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
The Dayton Air Compressor Co., 427 Valley St., Dayton, Ohio.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Titusville Iron Works Co., Titusville, Pa.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

PUMPS, Air and Oil Separator

INDIANA AIR PUMP CO., 816 INDIANA PYTHIAN BLDG., INDIANAPOLIS, IND.
INDIANA AIR LIFT PUMPING EQUIPMENTS complete or any part are furnished covering Air Lift Pumps, Air Compressor, Motors or Engine and Accessories; for Oil or Water.

PUMPS, Air Lift

INDIANA AIR PUMP COMPANY, 816 INDIANA PYTHIAN BLDG., INDIANAPOLIS, IND.
Indiana Air Lift Pumping Equipments complete or furnished covering Air Lift Pumps, Air Compressor, Motors or Engine and accessories; for oil or water.

PUMPS, Ammonia

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Viking Pump Co., Cedar Falls, Iowa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Barrel

The Deming Co., Salem, Ohio.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Viking Pump Co., Cedar Falls, Iowa.

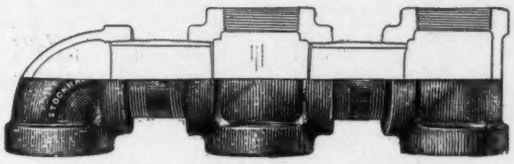
PUMPS, Bilge

YEOMANS BROTHERS CO., 1426 DAYTON ST., CHICAGO, ILL.
Established 1898.

PUMPS, Boiler Feed

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Coppus Engineering Corporation, Worcester, Mass.
The Dayton Air Compressor Co., 427 Valley St., Dayton, Ohio.
Dayton-Dowd Company, Quincy, Ill.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Economy Pumping Machinery Co., 3431 W. 48th Place, Chicago, Ill.
Furness Bros. Company, 1615 West Walnut St., Chicago, Ill.
Godfrey, Keeler Co., 70 Warren St., New York, N. Y.
Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

STOCKHAM FITTINGS
for Oil Country Pipe Lines



Stockham Fittings are made according to the American Standard. Absolute accuracy of pattern and perfect threads insure uniformity in any pipe line

OIL COUNTRY users demand a great deal in fittings—they must be made to give performance and durability under severe service. Stockham Fittings for over 25 years have accepted the responsibility for meeting the rigid requirements of oil country pipe lines. Manufactured to a high standard, strength far in excess of probable strain, uniform walls, clean, perfect threads, smooth inner and outer surfaces; always inspected and tested more rigidly than generally accepted standards require. Accuracy is the keynote in Stockham manufacture that makes Stockham Fittings dependable in performance for oil country pipe lines.

Cast Steel Flanged Fittings and Flanges. Conform to the American Standard. Walls are 3/16" in excess of American Standard Requirements. Regular in outline; conformity to patterns; ample fillets well rounded. Meet specifications of the American Society for Testing Materials. Chemical and physical tests from raw metal to casting insure the strength and soundness of Stockham Steel which is made by the electric furnace method. Free from impurities; never "doctored" in the ladle; no shrinkage; free from sand holes, blow holes, inclusions and cracks. Every fitting hydrostatically tested before shipment. Exceptionally smooth inner and outer surfaces; accurate facings and fine appearance. Made for pressures of 150, 300, 400, 600, 900 and 1350 lbs. and for temperatures according to the American Standard.

Cast Steel Screwed Fittings. Every needed design and size. Same quality standard as Flanged Fittings and Flanges. Accurate threads, accurate alignment, smooth inner surfaces. Strength far in excess of probable strain.

Cast Iron Fittings. Screwed—Flanged—Drainage. Made according to the American Standard. Accuracy in pattern, accuracy in proportioning materials, accuracy in melting, accuracy in molding, accuracy in finishing, accuracy in inspecting and testing.

Oil Country Malleables. Made from special patterns in every size, to particularly meet oil field requirements—these heavy malleables are annealed under definite temperature control, which gives ductility, uniform structure and high strength with great resistance to shock and strain.

Malleables. Regular and Extra Heavy. All Stockham Malleables are made according to the same quality standard which distinguishes all Stockham Fittings.

There are over 7,500 patterns in the complete Stockham line. Descriptive catalogs will be sent on request

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PIPE & FITTINGS COMPANY
BIRMINGHAM, ALABAMA

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Full lines of Stockham Fittings for the gas, oil field and refinery use are sold by the following oil country supply houses

Oklahoma and Texas
International Supply Company
E. L. Wilson Hardware Company

California
The Republic Supply Company
Petroleum Equipment Company

McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Pennsylavnia Pump and Compressor Co., Easton, Pa.
Wagener Steam Pump Co., Canton, Ohio.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Cargo

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Centrifugal

George B. Allan & Co., Simpson Building, Dallas, Texas.
American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
Dayton-Dowd Company, Quincy. Ill.
DEAN HILL PUMP CO., ANDERSON, IND.
Centrifugal Pumps for every service in the oil industry. Special construction features for Pumps handling gasoline, hot oil, etc.
De Laval Steam Turbine Co., Trenton, N. J.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Economy Pumping Machinery Co., 3431 W. 48th Place, Chicago, Ill.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
F. W. Gartner Company, Houston, Texas.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Pennsylavnia Pump and Compressor Co., Easton, Pa.
Titusville Iron Works Co., Titusville, Pa.
Union Engineering Co., Cleveland, Ohio.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.
YEOMANS BROTHERS CO., 1426 DAYTON ST., CHICAGO, ILL.
Dependable sewage, drainage, water supply, condensation, swimming pool, hot and cold water circulating centrifugal pumps. Heavy duty, long life machines. High efficiency, low operating cost.

PUMPS, Circulating

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
The Connersville Blower Co., Connersville, Ind.
Dayton-Dowd Company, Quincy. Ill.
Dean Hill Pump Co., Anderson, Ind.
Economy Pumping Machinery Co., 3431 W. 48th Place, Chicago, Ill.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
Mast, Foos & Co., Springfield, O.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Pennsylvania Pump and Compressor Co., Easton, Pa.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Condensation

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Dayton-Dowd Company, Quincy. Ill.
De Laval Steam Turbine Co., Trenton, N. J.
Economy Pumping Machinery Co., 3431 W. 48th Place, Chicago, Ill.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Pennsylavnia Pump and Compressor Co., Easton, Pa.
Wagener Steam Pump Co., Canton, Ohio.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

PUMPS, Deepwell Turbine

Byron Jackson Pump Co., Berkeley, Calif.

PUMPS, Duplex Steam

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Godfrey, Keeler Co., 70 Warren St., New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
National Transit Pump & Machine Co., 19 N. Petroleum St., Oil City, Pa.
Wagener Steam Pump Co., Canton, Ohio.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Exhausters, Jet

Blakeslee Mfg. Co., Du Quoin, Ill.

PUMPS, Fire Protection

Dayton-Dowd Company, Quincy. Ill.

PUMPS, Force

The Deming Co., Salem, Ohio.
F. W. Gartner Company, Houston, Texas.
A. L. Henderer's Sons, Maryland Ave. and Beech St., Wilmington, Delaware.
Mast, Foos & Co., Springfield, O.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Viking Pump Co., Cedar Falls, Iowa.

PUMPS, Fuel Oil

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
The Connersville Blower Co., Connersville, Ind.
Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
B. P. Lientz & Co., 3409 East 18th St., Kansas City, Mo.
Maxon Premix Burner Co., Muncie, Ind.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
Quimby Pump Co., Inc., 340 Thomas St., Newark, N. J.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
Viking Pump Co., Cedar Falls, Iowa.
Waterous Co., St. Paul, Minn.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Gear

De Laval Steam Turbine Co., Trenton, N. J.
The Deming Co., Salem, Ohio.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.

PUMPS, Hard Lead Centrifugal

Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
Dayton-Dowd Company, Quincy. Ill.

PUMPS, High Pressure Still

American Steam Pump Company, Battle Creek, Michigan.
Byron Jackson Pump Co., Berkeley, Calif.
Dean Hill Pump Co., Anderson, Ind.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Hot Oil

Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
The Connersville Blower Co., Connersville, Ind.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
Southern Engine & Pump Co., 615 Washington Ave., Houston, Tex.
Viking Pump Co., Cedar Falls, Iowa.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Hydraulic

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
Dayton-Dowd Company, Quincy. Ill.
De Laval Steam Turbine Co., Trenton, N. J.
The Deming Co., Salem, Ohio.
A. L. Henderer's Sons, Maryland Ave. and Beech St., Wilmington, Delaware.
The Hydraulic Press Mfg. Co., 20 East Broad, Columbus, Ohio.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
Wagener Steam Pump Co., Canton, Ohio.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Hydraulic Jet

Blakeslee Mfg. Co., Du Quoin, Ill.

PUMPS, Lead Acid

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
Dayton-Dowd Company, Quincy. Ill.

PUMP, Non-Clogging Sewage

Byron Jackson Pump Co., Berkeley, Calif.

PUMPS, Oil

American Steam Pump Company, Battle Creek, Michigan.
Blackmer Pump Co., Grand Rapids, Mich.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
The Connersville Blower Co., Connersville, Ind.
Dayton-Dowd Company, Quincy. Ill.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
Mast, Foos & Co., Springfield, O.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
McCullough Mfg. Co., 2632 Central Ave., Minneapolis, Minn.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
Wm. W. Nugent & Co., 410-12 N. Hermitage Ave., Chicago, Ill.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Quimby Pump Co., Inc., 340 Thomas St., Newark, N. J.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.
Viking Pump Co., Cedar Falls, Iowa.
Wagener Steam Pump Co., Canton, Ohio.
Waterous Co., St. Paul, Minn.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

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DETROIT, U.S.A.

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PUMPS, Oil Well

INDIANA AIR PUMP CO., 816 INDIANA PYTHIAN BLDG., INDIANAPOLIS, IND.

INDIANA AIR LIFT PUMPING EQUIPMENTS complete or any part are furnished covering Air Lift Pumps, Air Compressor, Motors or Engine and Accessories; for Oil or Water.

PUMPS, Pipe Line

Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
Dayton-Dowd Company, Quincy. Ill.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co., 11 Broadway. New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Power

American Steam Pump Company, Battle Creek, Michigan.
Bessemer Gas Engine Company, Grove City, Pa.
Blackmer Pump Co., Grand Rapids, Mich.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
The Deming Co., Salem, Ohio.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
LUITWIELER PUMPING ENGINE CO., 123 AMES ST., ROCHESTER, N. Y.
The Luitwieler system of deep well and reciprocating "non-pulsating" pumps are built in sizes of 1 to 50 HP, with capacities from 10 to 500 GPM. They may be driven by motor, gasoline engine, steam engine or any suitable driving power through belt, gear, chain, texrope, etc., controlled either manually or automatically.
Mast, Foos & Co., Springfield, O.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Northern Pump Co., Minneapolis, Minn.
Pennsylavnia Pump and Compressor Co., Easton, Pa.
Quimby Pump Co., Inc., 340 Thomas St., Newark, N. J.
Viking Pump Co., Cedar Falls, Iowa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Rotary

George B. Allan & Co., Simpson Building, Dallas, Texas.
Blackmer Pump Co., Grand Rapids, Mich.
The Connersville Blower Co., Connersville, Ind.
Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.
The Deming Co., Salem, Ohio.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Northern Pump Co., Minneapolis, Minn.
Quimby Pump Co., Inc., 340 Thomas St., Newark, N. J.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
Southern Engine & Pump Co., 615 Washington Ave., Houston, Tex.
VIKING PUMP CO., CEDAR FALLS, IOWA.
Viking Rotary Pumps employ but two moving parts which are self-supporting, eliminating excessive wear from friction. There are no springs, valves or small fittings to give trouble. Furnished in belt, motor and engine drive, in units of from 1 to 6 pumps with capacities from 2/3 to 1,050 G.P.M.
WATEROUS CO., INC., WATEROUS FIRE ENGINE WORKS, ST. PAUL, MINN.
Heavy Duty Rotary Pumps. Capacities 3 to 2000 G.P.M. for continuous operating. Pressures up to 300 lbs. Efficiencies up to 85 per cent., depending upon duty.
Westco-Chippewa Pump Co., Inc., Davenport, Iowa.

PUMPS, Rotary Air

The Connersville Blower Co., Connersville, Ind.
Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Northern Pump Co., Minneapolis, Minn.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

PUMPS, Rotary, Motor Driven

Blackmer Pump Co., Grand Rapids, Mich.
The Connersville Blower Co., Connersville, Ind.
The Deming Co., Salem, Ohio.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Northern Pump Co., Minneapolis, Minn.
Viking Pump Co., Cedar Falls, Iowa.

PUMPS, Rotary Vacuum

The Connersville Blower Co., Connersville, Ind.
Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.
Kinney Mfg. Co., Boston, Mass.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Northern Pump Co., Minneapolis, Minn.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

PUMPS, Sand, Gravel, Rock, Dredging

Byron Jackson Pump Co., Berkeley, Calif.

PUMPS, Screw

Byron Jackson Pump Co., Berkeley, Calif.
Quimby Pump Co., Inc., 340 Thomas St., Newark, N. J.

PUMPS, Sewage

YEOMANS BROTHERS CO., 1426 DAYTON ST., CHICAGO, ILL.
Pneumatic (air operated) and nonclogging (centrifugal), submerged and dry pit sewage pumps and ejectors. Dependable, long life machines for all types of buildings and municipal work. High efficiency, low operating cost.

PUMPS, Simplex

American Steam Pump Company, Battle Creek, Michigan.
The Deming Co., Salem, Ohio.
Furness Bros. Company, 1615 West Walnut St., Chicago, Ill.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Wagener Steam Pump Co., Canton, Ohio.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Sludge

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
The Connersville Blower Co., Connersville, Ind.
Ingersoll-Rand Co., 11 Broadway. New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
The P. H. & F. M. Roots Company, First & Water Street, Connersville, Indiana.
Titusville Iron Works Co., Titusville, Pa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Single Cylinder Steam

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Furness Bros. Company, 1615 West Walnut St., Chicago, Ill.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Wagener Steam Pump Co., Canton, Ohio.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Steam

American Steam Pump Company, Battle Creek, Michigan.
George B. Allan & Co., Simpson Building, Dallas, Texas.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Furness Bros. Company, 1615 West Walnut St., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Wagener Steam Pump Co., Canton, Ohio.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

PUMPS, Steam Jacketed

Blackmer Pump Co., Grand Rapids, Mich.
The Connersville Blower Co., Connersville, Ind.
GUYTON & CUMFER MFG. CO., 4441-59 FILLMORE ST., CHICAGO, ILL.
Guyton & Cumfer Mfg. Co. "Guycumbo."
Kinney Mfg. Co., Boston, Mass.
Quimby Pump Co., Inc., 340 Thomas St., Newark, N. J.
Viking Pump Co., Cedar Falls, Iowa.
Wagener Steam Pump Co., Canton, Ohio.

PUMPS, Steam Jet

Blakeslee Mfg. Co., Du Quoin, Ill.

PUMPS, Stripping

American Steam Pump Company, Battle Creek, Michigan.
Dean Hill Pump Co., Anderson, Ind.
Northern Pump Co., Minneapolis, Minn.

PUMPS, Sump

Byron Jackson Pump Co., Berkeley, Calif.
Economy Pumping Machinery Co., 3431 W. 48th Place, Chicago, Ill.

PUMPS, Tank

American Steam Pump Company, Battle Creek, Michigan.
Buffalo Steam Pump Co., 490 Broadway Ave., Buffalo, N. Y.
Byron Jackson Pump Co., Berkeley, Calif.
De Laval Steam Turbine Co., Trenton, N. J.
The Deming Co., Salem, Ohio.
Economy Pumping Machinery Co., 3431 W. 48th Place, Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
Mast, Foos & Co., Springfield, O.

May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
National Transit Pump & Machine Co., 19 N. Petroleum St., Oil City, Pa.
Sexton Can Co., Inc., 31 Cross St., Everett, Mass.
Viking Pump Co., Cedar Falls, Iowa.
Wagener Steam Pump Co., Canton, Ohio.

PUMPS, Transfer

Byron Jackson Pump Co., Berkeley, Calif.
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Kinney Mfg. Co., Boston, Mass.
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National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
Viking Pump Co., Cedar Falls, Iowa.
Wilson-Snyder Manufacturing Co., First & Talbot Sts., Braddock, Pa.

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Westco-Chippewa Pump Co., Inc., Davenport, Iowa.

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Bessemer Gas Engine Company, Grove City, Pa.
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Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Crowell Mfg. Co., 315 Franklin St., Brooklyn, N. Y.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Kinney Mfg. Co., Boston, Mass.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.
McCord Radiator & Mfg. Co., 2585 E. Grand Blvd., Detroit, Mich.
Northern Pump Co., Minneapolis, Minn.
Palo Company, 153 West 23rd St., New York, N. Y.
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Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Wagener Steam Pump Co., Canton, Ohio.
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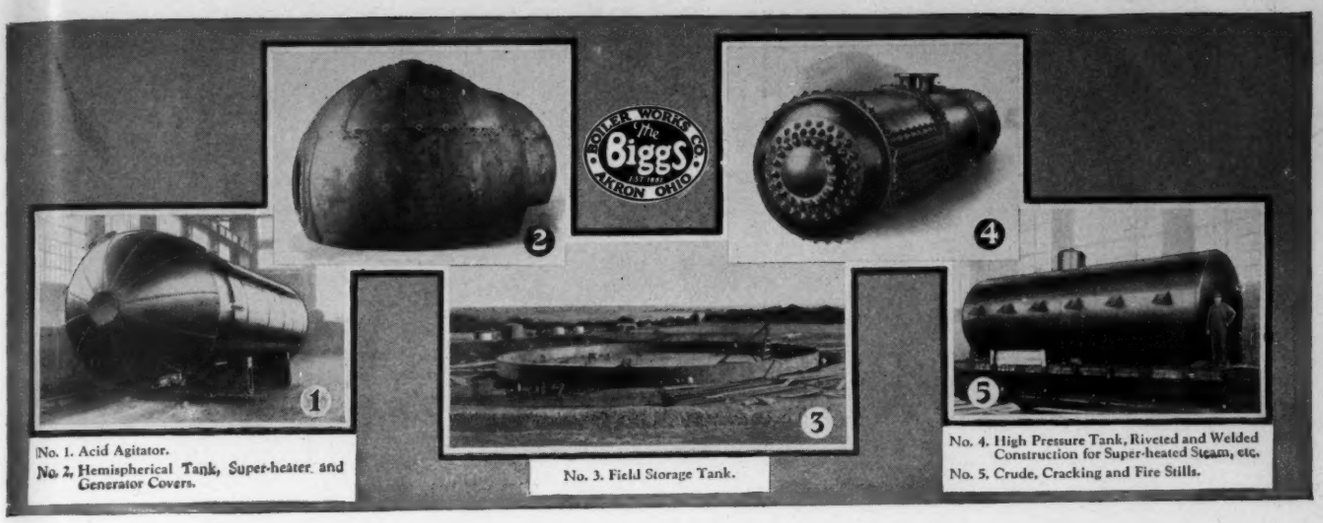

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H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

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Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

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Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
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Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.

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RECORDERS (See Instruments)

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The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.

RECORDERS, Speed

Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.
Electric Tachometer Corporation, 310 N. 11th Street, Philadelphia, Pa.

RECOVERY PLANTS

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Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

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Evans & Howard Fire Brick Co., 920 Market St., St. Louis, Mo.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
King Refractories Co., Inc., 1715 Niagara St., Buffalo, N. Y.
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Frick Company, Inc., Waynesboro, Pa.
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Audiffren Refrigerating Machine Co., 285 Madison Ave., New York, N. Y.
General Electric Co., Schenectady, New York.

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The Chaplin-Fulton Co., 28 Penn Ave., Pittsburgh, Pa.
The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.
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Leslie Company, Lyndhurst, N. J.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.

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The Chaplin-Fulton Co., 28 Penn Ave., Pittsburgh, Pa.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
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Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
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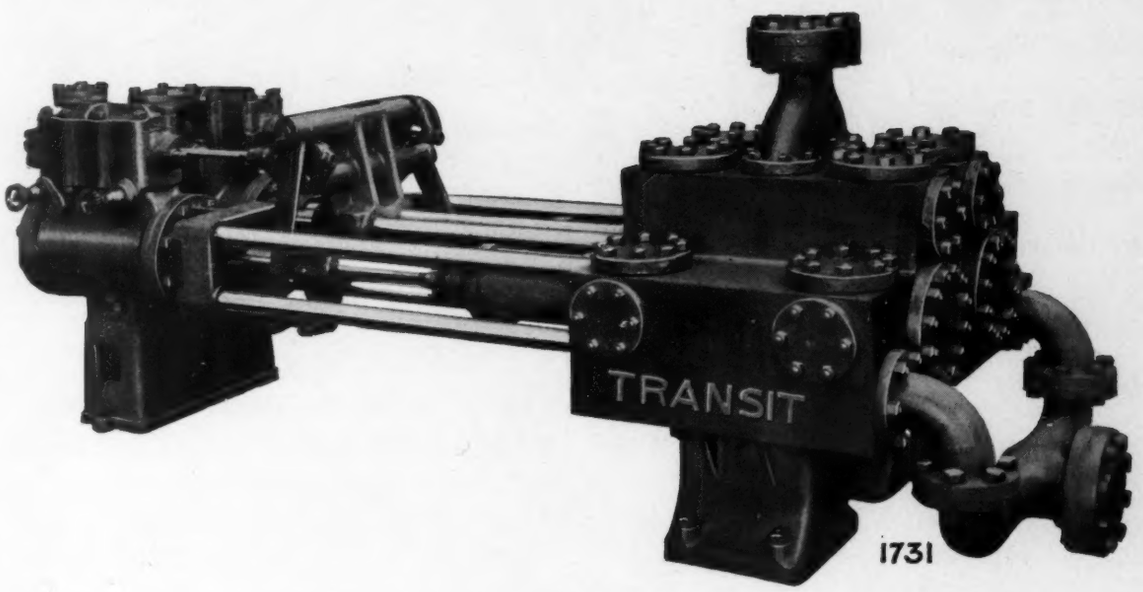

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Fisher Governor Co., Marshalltown, Iowa.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Houston Armature Works, Houston, Texas.

Leslie Company, Lyndhurst, N. J.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

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Taylor Instrument Companies, Rochester, N. Y.

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American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.

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A. W. Cash Co., Box 135, Decatur, Ill.

The Chaplin-Fulton Co., 28 Penn Ave., Pittsburgh, Pa.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.

Fisher Governor Co., Marshalltown, Iowa.

The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Leslie Company, Lyndhurst, N. J.

Magnolia Gas Products Co., Houston, Texas.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

MERCON REGULATOR COMPANY 53 S. JACKSON BLVD., CHICAGO, ILL.
See description under REGULATORS, Pressure.

Mueller Co., Decatur, Ill.

Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.

C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.

Taylor Instrument Companies, Rochester, N. Y.

REGULATORS, Auxiliary Pressure

A. W. Cash Co., Box 135, Decatur, Ill.

The Chaplin-Fulton Co., 28 Penn Ave., Pittsburgh, Pa.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Leslie Company, Lyndhurst, N. J.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

Mueller Co., Decatur, Ill.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

Taylor Instrument Companies, Rochester, N. Y.

REGULATORS, Back Pressure

A. W. Cash Co., Box 135, Decatur, Ill.

The Chaplin-Fulton Co., 28 Penn Ave., Pittsburgh, Pa.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

MERCON REGULATOR COMPANY 53 S. JACKSON BLVD., CHICAGO, ILL.
See description under REGULATORS, Pressure.

Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.

Oxweld Acetylene Company, 30 East 42nd St., New York, N. Y.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.

Taylor Instrument Companies, Rochester, N. Y.

Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

REGULATORS, Steam Pressure

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.

A. W. Cash Co., Box 135, Decatur, Ill.

Fisher Governor Co., Marshalltown, Iowa.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Leslie Company, Lyndhurst, N. J.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

MERCON REGULATOR COMPANY 53 S. JACKSON BLVD., CHICAGO, ILL.
See description under REGULATORS, Pressure.

Mueller Co., Decatur, Ill.

Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.

Taylor Instrument Companies, Rochester, N. Y.

REGULATORS, Water Pressure

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.

A. W. Cash Co., Box 135, Decatur, Ill.

The Chaplin-Fulton Co., 28 Penn Ave., Pittsburgh, Pa.

The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Leslie Company, Lyndhurst, N. J.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

MERCON REGULATOR COMPANY 53 S. JACKSON BLVD., CHICAGO, ILL.
See description under REGULATORS, Pressure.

Mueller Co., Decatur, Ill.

Taylor Instrument Companies, Rochester, N. Y.

REGULATORS, Speed

Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

REGULATORS, Stoker

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

REGULATORS, Tank

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.

Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.

The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

The Powers Regulator Co., 2750 Greenview Ave., Chicago, Ill.

Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

REGULATORS, Temperature

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.

Atlas Valve Co., 282-286 South St., Newark, N. J.

The Bristol Co., Waterbury, Conn.

Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.

W. H. Curtin & Co., 419 Washington Ave., Houston, Texas.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.

The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

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Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.

W. H. Curtin & Company, 419 Washington Ave., Houston, Tex.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

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Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

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Mueller Co., Decatur, Ill.

Taylor Instrument Companies, Rochester, N. Y.

REGULATORS, Speed

Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

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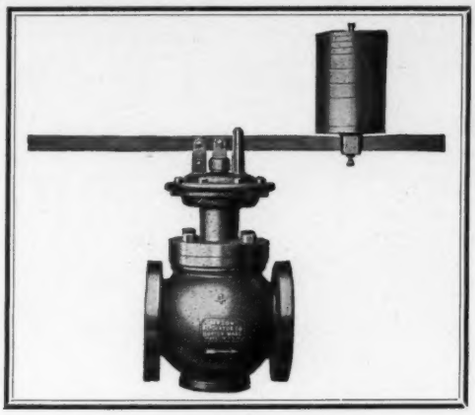

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Fisher Governor Co., Marshalltown, Iowa.
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Gustin-Bacon Manufacturing Co., 1412-1418 West 12th St., Sta. A., Kansas City, Mo.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.
Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

REGULATORS, Water Heater

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Mueller Co., Decatur, Ill.
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Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

REMOVERS, Paint

Oakite Products, Inc., 22 Thames St., New York, N. Y.

RESISTORS

General Electric Co., Schenectady, New York.

RESPIRATORS

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Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
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Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y.
The Refinery Supply Company, Tulsa, Oklahoma.

RESPIRATORS, Paint

Mine Safety Appliance Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

RESUSCITATION EQUIPMENT,

Frank S. Betz Co., Hammond, Ind.
Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

RETORTS, Gas

Laclede Christy Clay Prod. Co., 1711 Ambassador Bldg., St. Louis, Mo.

RETURN BENDS

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Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, New York.
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Ohiolock Frictionless. This bend includes the fast acting Ohiolock plug and is so constructed as to reduce to a minimum the internal friction in the bend and to provide an even flow of oil.
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Henry Vogt Machine Co., Louisville, Ky.
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RETURN SYSTEMS, Condensation

George B. Allan & Co., Simpson Building, Dallas, Texas.

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Cyclops Steel Co., Titusville, Pa.
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The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.
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RINGS, Asbestos Packing

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York City, N. Y.
Keasbey & Mattison Co., Ambler, Pa.

RINGS, Ceramic Raschig

The U. S. Stoneware Co., 50 Church St., New York, N. Y.

RINGS, Chemical

Laclede Christy Clay Prod. Co., 1711 Ambassador Bldg., St. Louis, Mo.
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COOKE SEAL RING CO., 30 NORTH GREEN ST., CHICAGO, ILL.
The Cooke Seal Ring is the mechanical seal that revolves with the shaft forming a ground joint with the bottom of the stuffing box and the gland. Leakage abolished—friction reduced to a minimum—scored shafts eliminated—lasts indefinitely. Is used on pumps, compressors, and everywhere where there is the problem of sealing against loss of liquid or gas, pressure or vacuum, around a revolving shaft.
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Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
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May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

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Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

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Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

RIVETS, Monel Metal

Equitable Equipment Company, Inc., 410 Camp St., New Orleans, La.

RIVET, Sets

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
May Machinery Company, Second Nat'l Bank Bldg., Houston, Texas.

RODS, Acid Resisting

The Duriron Company, Inc., Dayton, Ohio.

ROOF SHEATHING, Steel

Keasbey & Mattison Co., Ambler, Pa.

ROOFS, Tank

Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.

ROOFING, Asbestos

Keasbey & Mattison Co., Ambler,

ROOFING, Asbestos and Rag Felt

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
The Philip Carey Mfg. Co., Lockland, Ohio.
Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

ROOFING, Asphalt

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
The Philip Carey Mfg. Co., Lockland, Ohio.

ROOFING, Corrugated

R. V. Aycock Company, Kansas City, Mo.
Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Moncrief-Lenoir Mfg. Co., Houston, Texas.
The New Jersey Zinc Company, 160 Front Street, New York, N. Y.
The Philip Carey Mfg. Co., Lockland, Ohio.

ROOFING, Corrugated Asbestos

Rogers Asbestos Company, P. O. Box 1371, Houston, Texas.

ROOFING, Prepared

Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
The Philip Carey Mfg. Co., Lockland, Ohio.

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New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.
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The R. S. Manufacturing Co., 3404-06 Main St., Dallas, Texas.
The Refinery Supply Company, Tulsa, Oklahoma.
U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

RUNWAYS, Tank Car

North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

S

SADDLES, Manhole

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Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.
Laclede Christy Clay Prod. Co., 1711 Ambassador Bldg., St. Louis, Mo.
Mueller Co., Decatur, Ill.
M. B. Skinner Co., 562 Washington Blvd., Chicago, Ill.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

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Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y.

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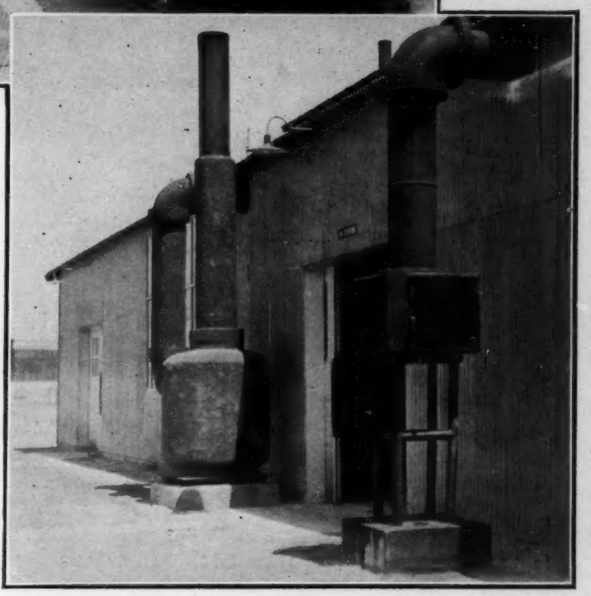

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Newark Wire Cloth Company, 364-378 Verona Ave., Newark, N. J.

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Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.

Jas. Clark, Jr., Electric Co., 600 E. Bargman St., Louisville, Ky.

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Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

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Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

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Providence Engineering Corp., Providence, R. I.

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J. A. Campbell, P. O. Box 669, Long Beach, Calif.

Fisher Governor Co., Marshall-Iowa.

Southwestern Engineering Corp., 1221 Hollingswo.th Bldg., Los Angeles, Calif.

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H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

Wyatt Metal & Boiler Works, Dallas, Texas.

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The Biggs Boiler Works Company, Akron, Ohio.

Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.

Elliott Co., Jeannette, Pa.

Fisher Governor Co., Marshalltown, Iowa.

Hardie-Tynes Mfg. Co., 8th Ave. & 28th St., Birmingham, Ala.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.

W. H. Nicholson & Co., 132 Oregon St., Wilkes-Barre, Pa.

H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

Power Plant Equipment Co., 2106 G. and Ave., Kansas City, Mo.

The Refinery Supply Company, Tulsa, Oklahoma.

Volz Engineering Corporation, 3732-3734 East 7th St., Long Beach. Calif.

SEPARATORS, Water

Burt Manufacturing Company, 929 S. High, Akron, Ohio.

De Laval Steam Turbine Co., Trenton, N. J.

Fisher Governor Co., Marshalltown, Iowa.

Geo. B. Limbert & Co., 570 Fulton St., Chicago, Ill.

H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

SHAFTING

The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.

We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.

A trial order will convince you that we are the proper source of supply for your steel requirements.

SHAFTING, Steel

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.

We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.

A trial order will convince you that we are the proper source of supply for your steel requirements.

SHEAVES

The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.

Marion Machine, Foundry & Supply Co., Box No. 685, Marion, Ind.

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

Union Engineering Co., Cleveland, Ohio.

SHEAVES, Rope

The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.

Union Engineering Co., Cleveland, Ohio.

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

SHEETS, Acid Resisting

The Duriron Company, Inc., Dayton, Ohio.

SHEETS, Galvanized

AMERICAN ROLLING MILL CO., MIDDLETOWN, OHIO.

ARMCO Ingot Iron sheets are especially adaptable to the most severe sheet metal service requirements. They have the purest possible iron base, and the finest grade of tightly adherent zinc coating.

Moncrief-Lenoir Mfg. Co., Houston, Texas.

SHELLAC

Cook Paint & Varnish Co., Kansas City, Mo.

SHINGLES, Asbestos

Keasbey & Mattison Co., Ambler, Pa.

SHINGLES, Metallic

The New Jersey Zinc Company, 160 Front Street, New York, N. Y.

SHOCK ABSORBERS, Gage

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

The Meriam Co., 8405 Detroit Ave., Cleveland, Ohio.

Provident Engineering Co., 39 Cortlandt St., New York, N. Y.

SIEVES, Testing

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Precision Scientific Co., 1736-54 N. Springfield Ave., Chicago, Ill.

SIGNS

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

SKYLIGHTS

American Cornice Works Co., Wichita, Kansas.

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

SMOKE STACKS

American Chimney Corporation, 147 Fourth Ave., New York, N. Y.

The Biggs Boiler Works Company, Akron, Ohio.

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.

Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.

Coatesville Boiler Works, Coatesville, Pa.

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

Connery & Co., Inc., Second & Luzerne Sts., Philadelphia, Pa.

Graver Corporation, East Chicago, Ind.

Hammond Iron Works, Warren, Pa.

The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.

Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.

Michelmann Steel Construction Co., Cor. of Second & Hampshire Sts., Quincy, Ill.

Mosher Steel and Machinery Co., Box 238, Dallas, Texas.

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.

Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

Wyatt Metal & Boiler Works, Dallas, Texas.

SOFTENERS, Water

American Water Softener Co., Lehigh Ave., at 4th St., Philadelphia, Pa.

Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.

Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.

Graver Corporation, East Chicago, Ind.

International Filter Co., 333 West 25th Place, Chicago, Ill.

H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

PERMUTIT CO., 440 FOURTH AVE., NEW YORK, N. Y.

Permutit zeolite water softeners may be had in any size from laboratory apparatus up to equipment delivering millions of gallons of completed softened water per day. To obtain an estimate of cost and the savings that can be effected send full description of purpose for which softened water is to be used, the quantity required and either an analysis or a 2 qt. sample of the water supply.

Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

Union Engineering Co., Cleveland, Ohio.

SOLDER

Aluminum Company of America, "Wear-Ever" Building, New Kensington, Pa.

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

SOLDERING IRONS, Electric

General Electric Co., Schenectady, New York.

SOLVENT, Engine Scale

Ward Chemical Company, Tulsa

SPADES

F. W. Gartner Company, Houston, Texas.

SPARK PLUGS

Bessemer Gas Engine Company, Grove City, Pa.

STITT IGNITION, COLUMBUS, OHIO.

For all makes of Gas, Gasoline and Kerosene Engines. Also trucks, tractors, automobiles and all heavy-duty motorized machinery.

SPECIALTIES, Steam

Fisher Governor Co., Marshalltown, Iowa.

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

Northern Valve Co., 806 Union St., Utica, N. Y.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

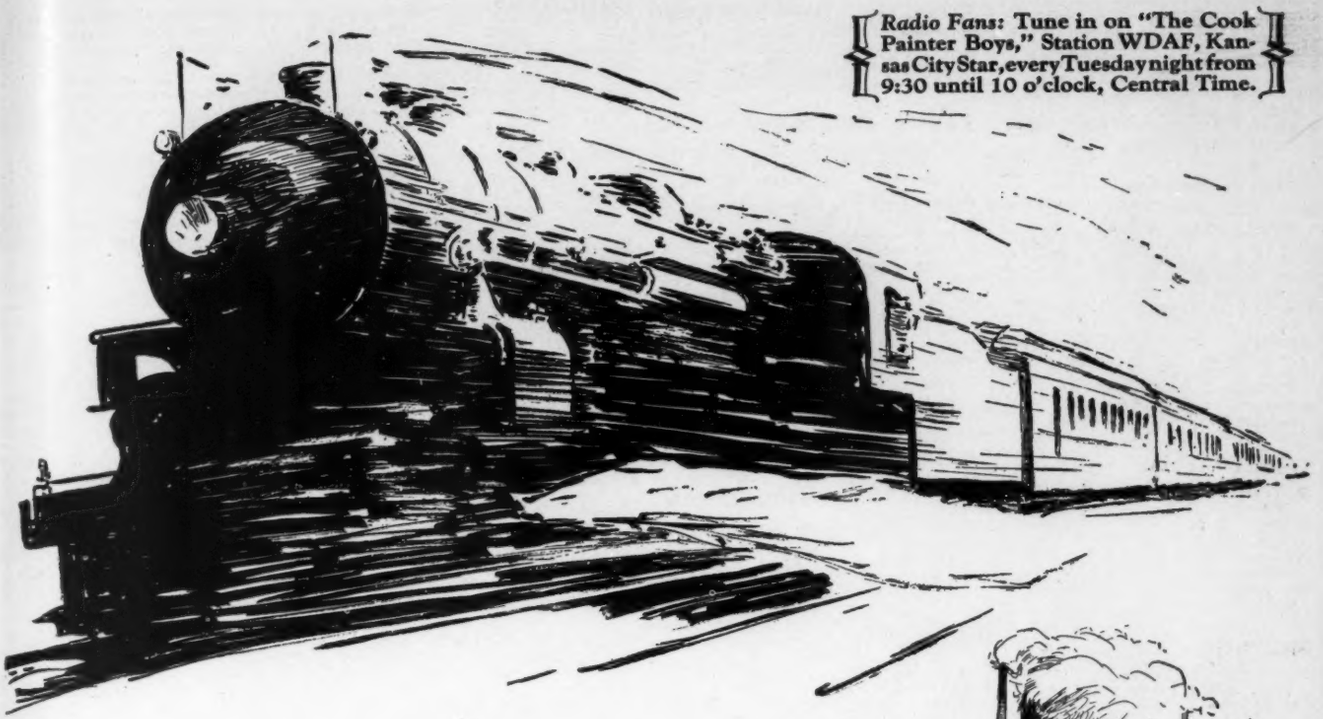
Smith Separator Company, Chestnut & Smith Co.p. Bldg., Tulsa, Oklahoma.

SPECIFIC GRAVITY, Apparatus

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.

Radio Fans: Tune in on "The Cook Painter Boys," Station WDAF, Kansas City Star, every Tuesday night from 9:30 until 10 o'clock, Central Time.



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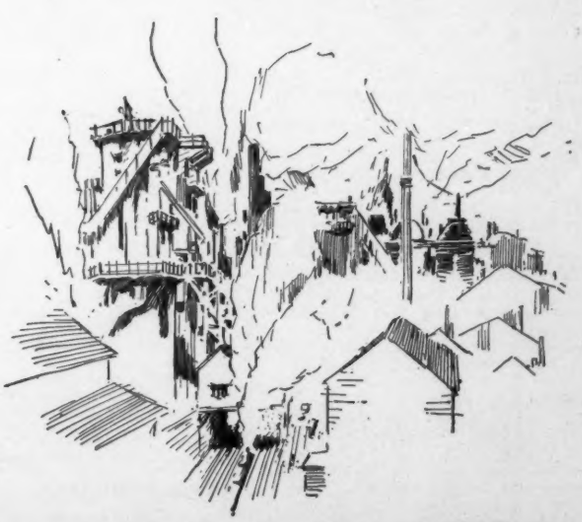

And Cook's, with five factories and ten branches located in the heart of the mid-continent oil fields, are able to give you *"right now" service!* Whether you need some of the famous paints we have perfected for the oil industry and carry always in stock—or whether you desire a special formula made to order on a moment's notice—Cook's have the equipment and the trained specialists to give you what you require, *pronto!* Just ask our nearest factory or branch!—COOK PAINT & VARNISH COMPANY.

COOK FACTORIES:

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St. Louis Cincinnati

COOK BRANCHES:

Tulsa Oklahoma City Wichita Dallas
Omaha Denver Kansas City, Kansas
St. Joseph, Missouri Chicago Detroit

SPECIALIZED PAINTS FOR THE OIL INDUSTRY

Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Metric Metal Works, Erie, Pa.
The R. S. Manufacturing Co., 3404-06 Main St., Dallas, Texas.
The Refinery Supply Company, Tulsa, Oklahoma.
Taylor Instrument Companies, Rochester, N. Y.

SPRAY, Nozzles

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
Binks Spray Equipment Co., 3114-26 Carroll Ave., Chicago, Ill.
Cook Paint & Varnish Co., Kansas City, Mo.
The Cooling Tower Co., 15 John St., New York, N. Y.
Malleable Iron Fittings Co., Branford, Conn.
H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.
Power Plant Equipment Co., 2106 Grand Ave., Kansas City, Mo.

SPRAYS, Paint

Binks Spray Equipment Co., 3114-26 Carroll Ave., Chicago, Ill.
Cook Paint & Varnish Co., Kansas City, Mo.
The DeVilbiss Company, 300-306 Phillips Ave., Toledo, Ohio.
The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.

SPRINGS

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

SPRINKLERS

Thompson Manufacturing Co., 2251 East 7th St., Los Angeles, Calif.

SPRINKLERS, Automatic

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.

SPROCKETS

The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Wilbraham Green Blowers Co., Pottstown, Pa.

STAIRS, Steel

Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Hammond Iron Works, Warren, Pa.
Kerlow Steel Flooring Company, 218-222 Culver Ave., Jersey City, N. J.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

STARTERS, Electric Motor

The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.
General Electric Co., Schenectady, New York.

STEEL, Alloy

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
A trial order will convince you that we are the proper source of supply for your steel requirements.

STEEL, Carbon

Crucible Steel Company of America, 17 E. 42nd St., New York, N.Y.
Cyclops Steel Co., Titusville, Pa.
Ludlum Steel Co., Watervliet, N. Y.
Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.
A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
A trial order will convince you that we are the proper source of supply for your steel requirements.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

STEEL, Drill Rod

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
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STEEL, Cold Drawn

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
A trial order will convince you that we are the proper source of supply for your steel requirements.

STEEL EQUIPMENT Office

Kolesch & Co., 138 Fulton St., New York, N. Y.

STEEL, Fabricated Structural

Braden Steel Corporation, 3 No. Madison, Tulsa, Okla.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Industrial Construction Co., 305 Central National Bank Bldg., Tulsa, Okla.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

STEEL, Hexagon, Hollow

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
A trial order will convince you that we are the proper source of supply for your steel requirements.

STEEL, High Speed

Crucible Steel Company of America, 17 E. 42nd St., New York, N.Y.
Cyclops Steel Co., Titusville, Pa.
Ludlum Steel Co., Watervliet, N. Y.
A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
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STEEL, Nickel

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
A trial order will convince you that we are the proper source of supply for your steel requirements.

STEEL, Octagon, Solid

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
A trial order will convince you that we are the proper source of supply for your steel requirements.

STEEL PLATE, Construction

The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Coatesville Boiler Works, Coatesville, Pa.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Connery & Co., Inc., Second & Luzerne Sts., Philadelphia, Pa.
Hammond Iron Works, Warren, Pa.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Newton Process Mfg. Co., Fullerton, Calif.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Struthers-Wells Co., Warren, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Henry Vogt Machine Co., Louisville, Ky.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.
Wyatt Metal & Boiler Works, Dallas, Texas.

STEEL, Reinforcing

Cyclops Steel Co., Titusville, Pa.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

SASH, Steel

Industrial Construction Co., 305 Central National Bank Bldg., Tulsa, Okla.

STEEL, Spring

A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
A trial order will convince you that we are the proper source of supply for your steel requirements.

STEEL, Structural

Braden Steel Corporation, 3 No. Madison, Tulsa, Okla.
Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Industrial Construction Co., 305 Central National Bank Bldg., Tulsa, Okla.

The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
The Petroleum Iron Works Co., Sharon, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Western Iron & Foundry Co., Second & Santa Fe Sts., Wichita, Kansas.

STEEL, Stainless or Rustless

The Calorizing Co., Pittsburgh, Pa.
Crucible Steel Company of America, 17 E. 42nd St., New York, N.Y.
Cyclops Steel Co., Titusville, Pa.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Ludlum Steel Co., Watervliet, N. Y.
MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

STEEL, Tool

Crucible Steel Company of America, 17 E. 42nd St., New York, N.Y.
Cyclops Steel Co., Titusville, Pa.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
Ludlum Steel Co., Watervliet, N. Y.
A. R. PURDY CO., INC., 790-4 GREENWICH STREET, NEW YORK, N. Y.
We specialize in Cold Rolled Shafting, Spring and Tool Steel in bars and sheets, Alloy Steels to S. A. E. Specifications, High Speed bars and bits, forgings, etc.
A trial order will convince you that we are the proper source of supply for your steel requirements.

STEPS, Grating

Blaw-Knox Co., Pittsburgh, Pa.
Kerlow Steel Flooring Company, 218-222 Culver Ave., Jersey City, N. J.

STILLS

PETROLEUM IRON WORKS CO., SHARON, PA.
P. I. W. "FLUID-FUSION" welded stills for high pressures and temperatures are built with walls 3 inches thick and heavier up to plate mill rolling limits. Dimensions and shape are restricted only transportation limits. "FLUID-FUSION" welded stills are produced by an exclusive automatic welding process. Every still is guaranteed.

STILLS, Cracking

Blaw-Knox Co., Pittsburgh, Pa.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
Graver Corporation, East Chicago, Ind.
Hammond Iron Works, Warren, Pa.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
The Petroleum Iron Works Co., Sharon, Pa.
Seamless Steel Equipment Corp., 39 Broadway, New York, N. Y.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

STILLS, Cylindrical

National Electric Heating Company, 420 Lexington Ave., New York, N. Y.

STILLS, Oil

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Graver Corporation, East Chicago, Ind.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.

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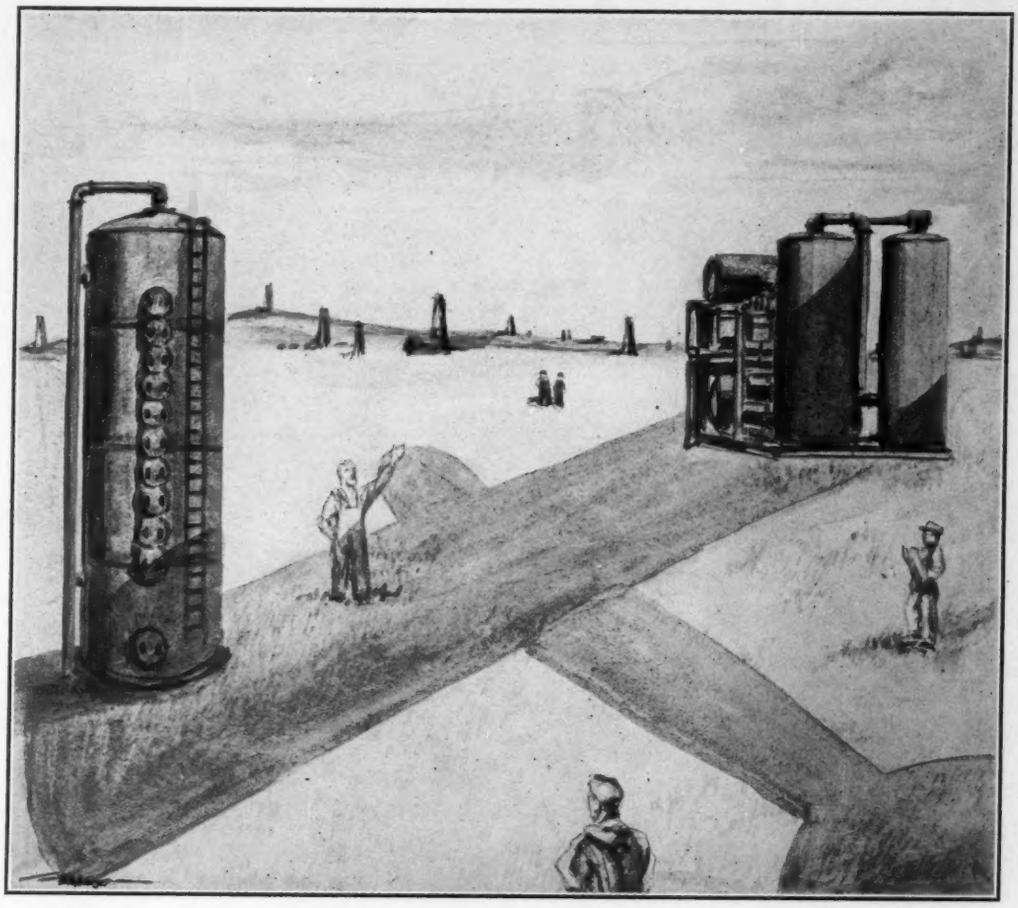

In fields throughout the Mid-Continent, Tulsa Type Equipment is the accepted standard of the leading Natural Gasoline Manufacturers. Selected because of its efficiency, flexibility and economy of design, Tulsa Type Equipment is first to embody the latest in engineering improvements. Designing for the needs of today, yet not forgetting the needs of tomorrow, keeps us ever alive to the spirit of progress.

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M. W. Kellogg Co., 7 Day St., New York, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Petroleum Iron Works Co., Sharon, Pa.
Struthers-Wells Co., Warren, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.
Wyatt Metal & Boiler Works, Dallas, Texas.

STILLS, Oil Laboratory

W. H. Curtin & Company, 419 Washington Ave., Houston, Tex.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
The Refinery Supply Company, Tulsa, Oklahoma.

STILLS, Pipe

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
Graver Corporation, East Chicago, Ind.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
The Petroleum Iron Works Co., Sharon, Pa.
Struthers-Wells Co., Warren, Pa.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

STILLS, Pressure

The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
Graver Corporation, East Chicago, Ind.
Hammond Iron Works, Warren, Pa.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Newton Process Mfg. Co., Fullerton, Calif.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
The Petroleum Iron Works Co., Sharon, Pa.
Seamless Steel Equipment Corp., 39 Broadway, New York, N. Y.
A. O. Smith Corporation, Milwaukee, Wis.
Sowers Manufacturing Co., 1305 Magra St., Buffalo, N. Y.
Struthers-Wells Co., Warren, Pa.
Henry Vogt Machine Co., Louisville, Ky.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

STILLS, Steam

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
The Biggs Boiler Works Company, Akron, Ohio.
C. F. Braun & Co., Alhambra, California.
J. A. Campbell, P. O. Box 669, Long Beach, Calif.
Hammond Iron Works, Warren, Pa.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Newton Process Mfg. Co., Fullerton, Calif.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
The Petroleum Iron Works Co., Sharon, Pa.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Sowers Manufacturing Co., 1305 Magra St., Buffalo, N. Y.
Struthers-Wells Co., Warren, Pa.
Henry Vogt Machine Co., Louisville, Ky.

STILLS, Tube

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
The Biggs Boiler Works Company, Akron, Ohio.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
The Petroleum Iron Works Co., Sharon, Pa.
National Electric Heating Co., 420 Lexington Ave., New York, N. Y.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Struthers-Wells Co., Warren, Pa.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.

STILLS, Vacuum

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
Graver Corporation, East Chicago, Ind.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
M. W. Kellogg Co., 7 Day St., New York, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
Ross Heater & Mfg. Company, Inc., 1407-1411 West Ave., Buffalo, N. Y.
Struthers-Wells Co., Warren, Pa.

STILLS, Water

E. B. Badger & Sons Co., 63 Pitts Street, Boston, Mass.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
International Filter Co., 333 West 25th Place, Chicago, Ill.
Precision Scientific Co., 1736-54 N. Springfield Ave., Chicago, Ill.

STOCKS AND DIES

The Armstrong Mfg. Co., 27 Cleveland Place, near Spring St., New York, N. Y.

STOKERS

Rosedale Foundry & Machine Co., Columbus and Preble Aves., N. S., Pittsburgh, Pa.

STOPPERS

W. H. Curtin & Company, 419 Washington Ave., Houston, Tex.

STOPPERS, Rubber

W. H. Curtin & Company, 419 Washington Ave., Houston, Tex.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.

STOPS, Limit

The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.

STRAINERS, Air

American Liquid Meter Co., 2217 Orange St., Alhambra, Cal.
A. W. Cash Co., Box 135, Decatur, Ill.
Fisher Governor Co., Marshalltown, Iowa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
Mueller Co., Decatur, Ill.
Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

STRAINERS, Duplex

Leslie Company, Lyndhurst, N. J.

STRAINERS, Oil

Wm. W. Nugent & Co., 410-12 N. Hermitage Ave., Chicago, Ill.
Providence Engineering Corp., Providence, R. I.

STRAINERS, Self-Cleaning

Leslie Company, Lyndhurst, N. J.

STRAINERS, Steam

George B. Allan & Co., Simpson Building, Dallas, Texas.
A. W. Cash Co., Box 135, Decatur, Ill.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Mueller Co., Decatur, Ill.
Providence Engineering Corp., Providence, R. I.
Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

STRAINERS, Twin

Leslie Company, Lyndhurst, N. J.

STRAINERS, Water

C. F. Braun & Co., Alhambra, California.
Buffalo Meter Company, 2929 Main St., Buffalo, N. Y.
A. W. Cash Co., Box 135, Decatur, Ill.
Elliott Co., Jeannette, Pa.
Fisher Governor Co., Marshalltown, Iowa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
Mueller Co., Decatur, Ill.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
Providence Engineering Corp., Providence, R. I.
Rosedale Foundry & Machine Co., Columbus and Preble Aves., N. S., Pittsburgh, Pa.
Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

STRETCHERS

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

STRETCHER OUTFITS

Mine Safety Appliances Co., Braddock Ave. and Thomas Blvd., Pittsburgh, Pa.

STRIPPERS, Paint

Oakite Products, Inc., 22 Thames St., New York, N. Y.

STUDS, Metal

Henry Vogt Machine Co., Louisville, Ky.

SUPERHEATERS

George B. Allan & Co., Simpson Building, Dallas, Texas.
Badenhausen Corporation, 900 Victory Bldg., Philadelphia, Pa.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
National Electric Heating Company, 420 Lexington Ave., New York, N. Y.
The Power Plant Equipment Co., Coca Cola Building, Kansas City, Mo.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

SUPPLIES, Drafting Room

Kolesch & Co., 138 Fulton St., New York, N. Y.
U. S. Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

SUPPLIES, Engineering

Kolesch & Co., 138 Fulton St., New York, N. Y.
New York Blue Print Paper Co., 96-102 Reade St., New York, N. Y.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.
U. S. Blue Print Paper Co., 207 S Wabash Ave., Chicago, Ill.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

SUPPLIES, Welding

General Electric Co., Schenectady, New York.

SWING LINE, Equipment

Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

SWITCHES, Limit

The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.
Electric Tachometer Corporation, 310 N. 11th Street, Philadelphia, Pa.
General Electric Co., Schenectady, New York.

SWITCHES, Pressure

The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.
Fisher Governor Co., Marshalltown, Iowa.
General Electric Co., Schenectady, New York.
Houston Armature Works, Houston, Texas.

SWITCHBOARDS

General Electric Co., Schenectady, New York.
Houston Armature Works, Houston, Texas.

SYPHONS

Carl H. Wagner & Sons, 1944 W. Albany Ave., Chicago, Ill.

SYPHONS, Steam Jet

Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.

SYSTEMS, Heating and Ventilating

Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

SYSTEMS, Oiling

Wm. W. Nugent & Co., 410-12 N. Hermitage Ave., Chicago, Ill.

T

TABLES, Office

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

TACHOMETERS

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.
W. H. Curtin & Company, 419 Washington Ave., Houston, Tex.
Electric Tachometer Corporation, 310 N. 11th Street, Philadelphia, Pa.
Gray Instrument Co., 64-70, West Johnson St., Germantown, Philadelphia, Pa.
Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

TANK CARS

Carnes Equipment Company, Box 595, Sand Springs, Oklahoma.
Conley Tank Car Co., 747 Oliver Bldg., Pittsburgh, Pa.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
The Petroleum Iron Works Co., Sharon, Pa.

TANK CARS, Compartment

Conley Tank Car Co., 747 Oliver Bldg., Pittsburgh, Pa.

TANK CARS, Insulated

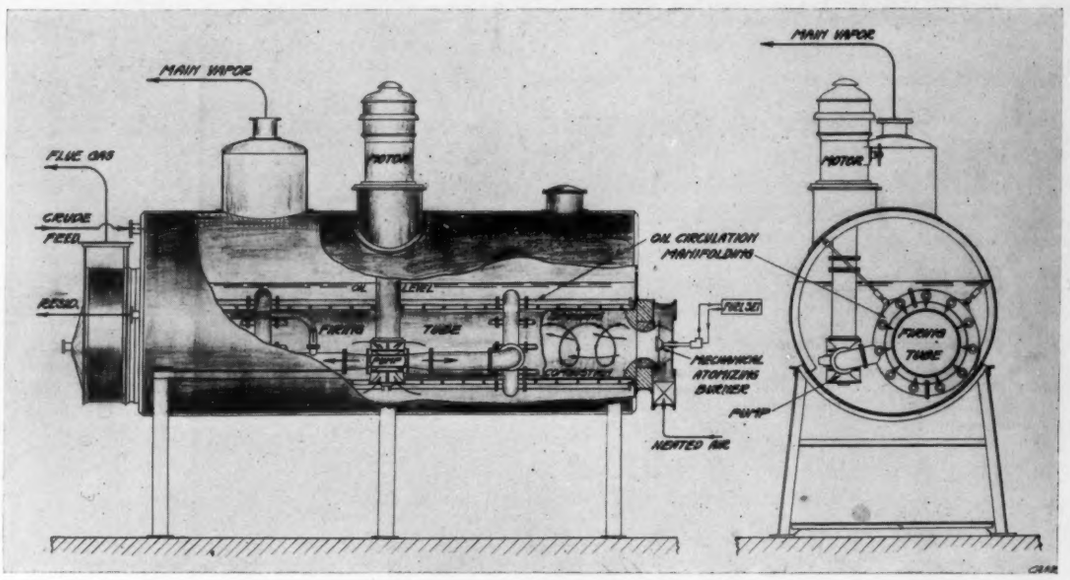
Carnes Equipment Company, Box 595, Sand Springs, Oklahoma.
Conley Tank Car Co., 747 Oliver Bldg., Pittsburgh, Pa.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
The Petroleum Iron Works Co., Sharon, Pa.

TANK CONNECTIONS

Carnes Equipment Company, Box 595, Sand Springs, Oklahoma.

OIL CIRCULATION STILLS

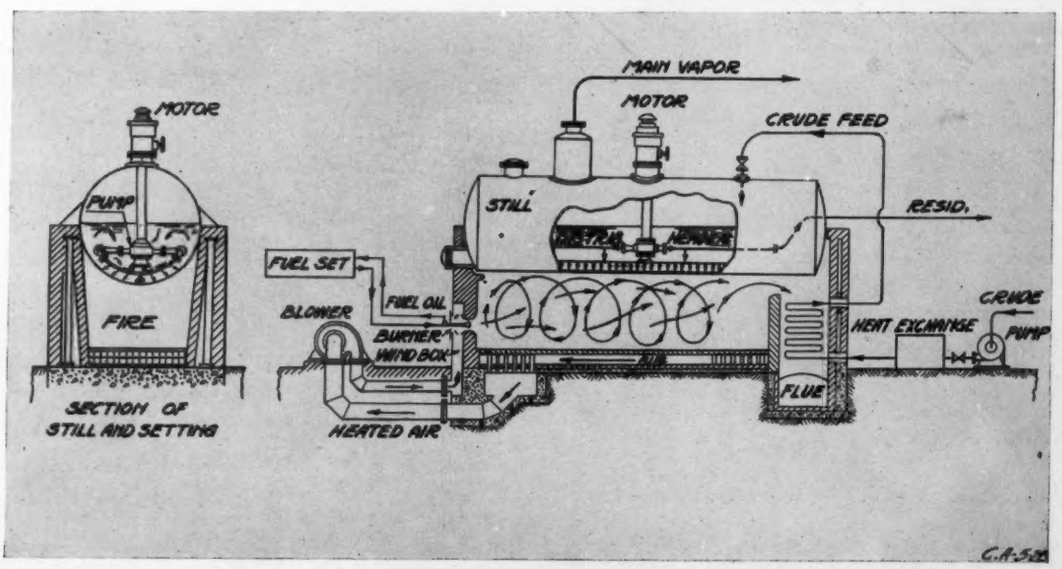
and Complete Accessory Equipment



INSIDE FIRED TYPE

Lowest capital investment—Maximum heat transfer capacity—Highest thermal efficiency—Longest continuous service—Minimum operating and maintenance expense—Automatic control.

Design and construction of complete distilling and fractionating units by experienced petroleum refining engineers.



BOTTOM FIRED TYPE

STRATFORD ENGINEERING CO.

PETROLEUM REFINING ENGINEERS

KANSAS CITY, MO.

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

TANK DECKS, Floating, Fire Proof, Evaporation Proof

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

TANK KOAT, Acid Proof

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

TANKS

Bessemer Gas Engine Company, Grove City, Pa.
Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Carnes Equipment Company, Box 595, Sand Springs, Oklahoma.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Coatesville Boiler Works, Coatesville, Pa.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Connery & Co., Inc., Second & Luzerne Sts., Philadelphia, Pa.
Erie City Iron Works, Erie City, Pa.
Graver Corporation, East Chicago, Ind.
Hammond Iron Works, Warren, Pa.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Mosher Steel and Machinery Co., Box 238, Dallas, Texas.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

TANKS, Accumulators

Bessemer Gas Engine Company, Grove City, Pa.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Henry Vogt Machine Co., Louisville, Ky.
Wyatt Metal & Boiler Works, Dallas, Texas.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.

TANKS, Acid

North American Car Corp., Petroleum Bldg., Tulsa, Okla.

TANKS, Acid-proof Chemical Stoneware

The U. S. Stoneware Co., 50 Church St., New York, N. Y.

TANKS, Agitators

Blaw-Knox Co., Pittsburgh, Pa.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Graver Corporation, East Chicago, Ind.
The Hill Clutch Machine & Foundry Co., 6400 Breakwater Avenue, Cleveland, Ohio.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Mixing Equipment Co., Inc., 229 East 38th St., New York, N. Y.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Union Engineering Co., Cleveland, Ohio.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

TANKS, Air

Bessemer Gas Engine Company, Grove City, Pa.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Hammond Iron Works, Warren, Pa.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Seamless Steel Equipment Corp., 39 Broadway, New York, N. Y.
Struthers-Wells Co., Warren, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

TANKS, Bolted

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.

TANKS, Compression

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Kewanee Boiler Corporation, Kewanee, Ill.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

TANKS, Copper

Buffalo Foundry & Machine Co., 1569 Fillmore Ave., Buffalo, N. Y.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.

TANKS, Elevated

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
Southern Engine & Pump Co., 615 Washington Ave., Houston, Tex.

TANKS, Gasoline

Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

TANKS, Impregnating

National Electric Heating Company, 420 Lexington Ave., New York, N. Y.

TANKS, Pressure

The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Hammond Iron Works, Warren, Pa.
Kewanee Boiler Corporation, Kewanee, Ill.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Seamless Steel Equipment Corp., 39 Broadway, New York, N. Y.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Struthers-Wells Co., Warren, Pa.
Titusville Iron Works Co., Titusville, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Henry Vogt Machine Co., Louisville, Ky.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

TANKS, Reaction

National Electric Heating Company, 420 Lexington Ave., New York, N. Y.

TANKS, Run Down

Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Graver Corporation, East Chicago, Ind.
Hammond Iron Works, Warren, Pa.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Henry Vogt Machine Co., Louisville, Ky.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

TANKS, Storage

Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Carnes Equipment Company, Box 595, Sand Springs, Oklahoma.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Connery & Co., Inc., Second & Luzerne Sts., Philadelphia, Pa.
Graver Corporation, East Chicago, Ind.
Hammond Iron Works, Warren, Pa.
The Kaw Steel Construction Co., 1st St. & Walker Ave., Kansas City, Kansas.
Kewanee Boiler Corporation, Kewanee, Ill.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Moncrief-Lenoir Mfg. Co., Houston, Texas.
National Electric Heating Company, 420 Lexington Ave., New York, N. Y.
North American Car Corp., Petroleum Bldg., Tulsa, Okla.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
Titusville Iron Works Co., Titusville, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Union Engineering Co., Cleveland, Ohio.
United Iron Works, Inc., Ridge Arcade Bldg., Kansas City, Mo.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

TANKS, Truck

Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

TANKS, Welded

Blaw-Knox Co., Pittsburgh, Pa.
Butler Manufacturing Company, 13th & Eastern Ave., Kansas City, Mo.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, 2463 Old Colony Bldg., Chicago, Ill.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Connery & Co., Inc., Second & Luzerne Sts., Philadelphia, Pa.
Graver Corporation, East Chicago, Ind.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
Power Piping Co., 829 Beaver Ave., Pittsburgh, Pa.
Robinson Ventilating Co., 517 House Bldg., Pittsburgh, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Struthers-Wells Co., Warren, Pa.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
Wyatt Metal & Boiler Works, Dallas, Texas.

TAPES, Gauging

THE LUFKIN RULE CO., SAGINAW, MICH.
"Atlas" and other tapes with plumb bobs.

TAPES, Measuring

A. S. Aloe Co., 1819 Olive St., St. Louis, Mo.
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Steel and Woven Tapes for general measuring, also Steel Tapes with plumb bobs for tank gaging.

TAPS

Greenfield Tap & Die Corporation, Greenfield, Mass.

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Gray Instrument Co., 64-70, West Johnson St., Germantown, Philadelphia, Pa.

TESTERS (See Scientific Instruments)

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
W. H. Curtin & Company, 419 Washington Ave., Houston, Tex.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Kolesch & Co., 138 Fulton St., New York, N. Y.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
Taylor Instrument Companies, Rochester, N. Y.

THAWING OUTFITS, Electric for thawing frozen piping in winter.

The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.

THERMO - COMPRESSORS

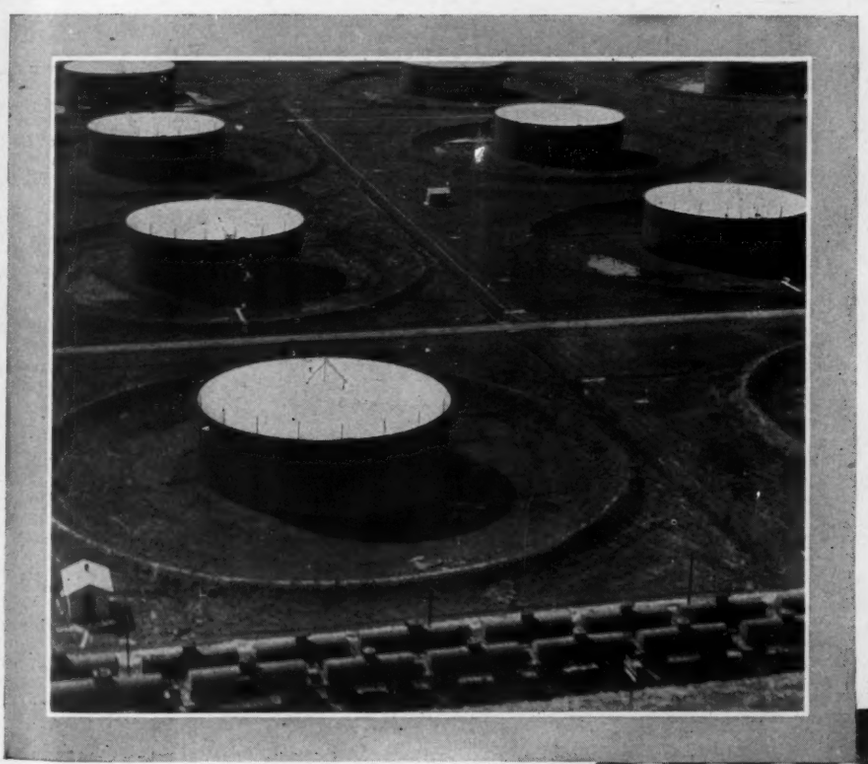
Elliott Co., Jeannette, Pa.

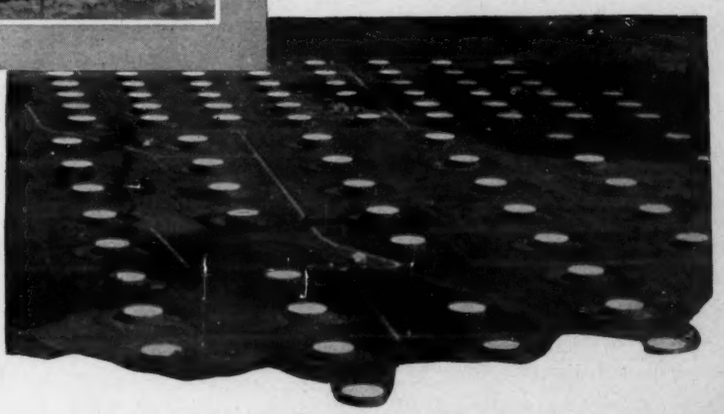
A Johns-Manville Insulated Tank Top Pays for Itself in Six Months

These Vaportight Tops control evaporation loss and save hundreds of barrels of oil

WHEREVER the oil industry has storage problems, remarkable savings are being effected by the use of Johns-Manville Vaportight Insulated Tank Tops. These tops eliminate "wind drift" losses and materially reduce loss due to "breathing." In a recent installation on standard 55,000 barrel wood deck tanks, these Johns-Manville Tops showed proved savings running as high as $5,000 per year per tank. On this basis, the Top pays for itself in six to eight months and the investment represents a clear saving thereafter.

In the West Texas fields where crude has a high sulphur content the resulting corrosion of Steel Tank Tops makes the use of wood decks a necessity. Under these conditions, Johns-Manville Vaportight Tops are especially effective. In addition to reduction of evaporation loss, protection against the effects of lightning is equally important. In over 1,000 installations of Johns-Manville Tops over wood decks where our special grounded conductor network has also been installed, there is not one instance of fires resulting from secondary lightning discharge.





General view of oil tanks equipped with Johns-Manville VAPORTIGHT Tank Top and Grounded Conductor Network.

At right is shown partial view of one of the largest refinery storages in the country. The more than 100 tanks here are equipped with Johns-Manville VAPORTIGHT Tops.

THE thousands of dollars yearly saving that can be accomplished by using Johns-Manville Vaportight Tops should interest every oil producer. Mail the coupon today and let us send you complete information regarding the Johns-Manville system.

MASTER *of* ASBESTOS

Johns-Manville

VAPORTIGHT TANK TOPS

JOHNS-MANVILLE CORPORATION
New York, Chicago, Cleveland, San Francisco
Branches in all large cities
Canadian Johns-Manville Co., Ltd., Toronto
(Mail this coupon to branch nearest you.)

We should like to discuss Tank Tops and Lightning Prevention with your representative.

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Address .....

City ..... State .....

TT-54-6

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Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.

THERMO-COUPLES

Brown Instrument Co., 4537 Wayne Ave., Philadelphia, Pa.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.
ILLINOIS TESTING LABORATORIES, INC., 141 W. AUSTIN AVE., CHICAGO, ILL.
All types furnished for any make of pyrometer, also any type repaired and tested.
Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.
Taylor Instrument Companies, Rochester, N. Y.
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Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.
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All makes and types repaired, 48-hour service if desired.

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The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
The Foxboro Co., Inc., 243 S. Cincinnati St., Foxboro, Mass.
Henry J. Green, 1191 Bedford Ave., Brooklyn, N. Y.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.
Illinois Testing Laboratories, Inc., 141-143 W. Austin Ave., Chicago, Ill.
Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
National Gauge Company, 300 Pacific St., Brooklyn, N. Y.
Palo Company, 153 West 23rd St., New York, N. Y.
The Powers Regulator Co., 2750 Greenview Ave., Chicago, Ill.
The Refinery Supply Company, Tulsa, Oklahoma.
Sarco Co., Inc., 183 Madison Ave., New York, N. Y.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.
Carl H. Wagner & Sons, 1944 W. Albany Ave., Chicago, Ill.
Taylor Instrument Companies, Rochester, N. Y.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.
Wilson-Maeulen Co., Inc., 381 Concord Ave., New York, N. Y.

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THERMOMETERS, Dial Indicating

The Powers Regulator Co., 2750 Greenview Ave., Chicago, Ill.

THERMOMETERS, Industrial

Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.

THERMOMETERS, Laboratory

Hiergesell Brothers, 2007-13 Bellevue Ave., Philadelphia, Pa.

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ILLINOIS TESTING LABORATORIES, INC., 141 W. AUSTIN AVE., CHICAGO, ILL.
Low cost resistance thermometers.

THERMOSTATS

The Bristol Co., Waterbury, Conn.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
General Electric Co., Schenectady, New York.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Griebel Instrument Co., Carbondale, Pa.
The Powers Regulator Co., 2750 Greenview Ave., Chicago, Ill.
Sarco Co., Inc., 183 Madison Ave., New York, N. Y.
Taylor Instrument Companies, Rochester, N. Y.

THIEVES, Oil

Barnhart-Davis Co., Warren, Pa.
W. H. Curtin & Company, 419 Washington Ave., Houston, Tex.
The Fort Worth Laboratories, 828½ Monroe St., Fort Worth, Texas.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
The Refinery Supply Company, Tulsa, Oklahoma.
C. J. Tagliabue Mfg. Co., 18 Thirty-Third St., Brooklyn, N. Y.

TILE, Acid-proof Chemical Stoneware

The U. S. Stoneware Co., 50 Church St., New York, N. Y.

TILE, Boiler

Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Evans & Howard Fire Brick Co., 920 Market St., St. Louis, Mo.

TILE, Fire Clay

Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.
The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Evans & Howard Fire Brick Co., 920 Market St., St. Louis, Mo.

TILE, Hollow Building

Acme Brick Co., Fort Worth, Tex.

TOOLS AND ACCESSORIES, Pneumatic

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.

TOOLS, Beading

A. L. Henderer's Sons, Maryland Ave. and Beech St., Wilmington, Delaware.

TOOLS, Concrete Cutting

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Cyclops Steel Co., Titusville, Pa.

TOOLS, Flaring

A. L. Henderer's Sons, Maryland Ave. and Beech St., Wilmington, Delaware.

TOOLS, Machine

Jas. Clark, Jr., Electric Co., 600 E. Bargman St., Louisville, Ky.
Cyclops Steel Co., Titusville, Pa.

TOOLS, Planing

Cyclops Steel Co., Titusville, Pa.

TOOLS, Pneumatic

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Dayton Pneumatic Tool Corp., 408 Ray St., Dayton, Ohio.

TOOL POST, Portable, Electric

Jas. Clark, Jr., Electric Co., 600 E. Bargman St., Louisville, Ky.

TOOLS, Rivet Cutting

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.
Dayton Pneumatic Tool Corp., 408 Ray St., Dayton, Ohio.

TOOLS, Scaling

Chicago Pneumatic Tool Company, 6 East 44th St., New York, N. Y.

TORCHES, Blow

Magnolia Gas Products Co., Houston, Texas.
Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill.

TORCHES, Cutting

Magnolia Gas Products Co., Houston, Texas.
National Oxygen Co., 29 S. LaSalle St., Chicago, Ill.
Oxweld Acetylene Company, 30 East 42nd St., New York, N. Y.
Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill.

TORCHES, Pipe Bending

The MacLeod Co., 2232 Bogen St., Cincinnati, Ohio.

TOWERS

Mosher Steel and Machinery Co., Box 238, Dallas, Texas.

TOWERS, Absorber

The Biggs Boiler Works Company, Akron, Ohio.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Hammond Iron Works, Warren, Pa.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
A. O. Smith Corporation, Milwaukee, Wisconsin.
Struthers-Wells Co., Warren, Pa.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.
Wyatt Metal & Boiler Works, Dallas, Texas.

TOWERS, Acid-proof, Chemical Stoneware

U. S. Stoneware Company, 50 Church Street, New York, N. Y.

TOWERS, Atmospheric Cooling

Fluor Construction Co., 909 E. 50th St., Los Angeles, Calif.
Jackson Engineering & Equipment Co., 909 E. 59th St., Los Angeles, California.

TOWERS, Bubble

American Radiator Co., 816 S. Michigan Ave., Chicago, Ill.
The Biggs Boiler Works Company, Akron, Ohio.
Blaw-Knox Co., Pittsburgh, Pa.
C. F. Braun & Co., Alhambra, California.
Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
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M. W. Kellogg Co., 7 Day St., New York, N. Y.
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Newton Process Mfg. Co., Fullerton, Calif.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
The Petroleum Iron Works Co., Sharon, Pa.
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A. O. Smith Corporation, Milwaukee, Wisconsin.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
Struthers-Wells Co., Warren, Pa.
Henry Vogt Machine Co., Louisville, Ky.
Vulcan Steel Tank Corp., Box 1844, Tulsa, Okla.
The Winkler-Koch Engineering Co., 429 First National Bank Bldg., Wichita, Kansas.
Wyatt Metal & Boiler Works, Dallas, Texas.

TOWERS, Cascade

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Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.

TOWERS, Cooling

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Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
The Cooling Tower Co., 15 John St., New York, N. Y.
Fluor Construction Co., 909 E. 50th St., Los Angeles, Calif.
Foster Wheeler Corporation, 165 Broadway, New York, N. Y.
Jackson Engineering & Equipment Co., 909 E. 59th St., Los Angeles, California.
Lancaster Iron Works, Inc., 650 S. Prince St., Lancaster, Pa.
Newton Process Mfg. Co., Fullerton, Calif.
Pennsylvania Furnace & Iron Co., 316 Pine St., Warren, Pa.
Power Plant Equipment Co., 2106 Grand Ave., Kansas City, Mo.
Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.
C. H. Wheeler Mfg. Co., Philadelphia, Pa.

TOWERS, Gray

M. W. Kellogg Co., 7 Day St., New York, N. Y.

TOWERS, Vaporizing

The Biggs Boiler Works Company, Akron, Ohio.
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
Heat Transfer Products, Inc., 90 West St., New York, N. Y.

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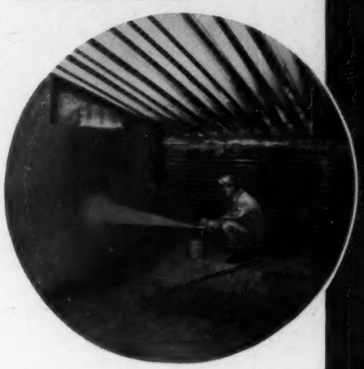

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W. H. Nicholson & Co., 132 Oregon St., Wilkes-Barre, Pa.

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Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
Provident Engineering Co., 39 Cortlandt St., New York, N. Y.
Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.
Tulsa Boiler & Machine Co., P. O. Box 1963, Tulsa, Okla.

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Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.
W. H. Curtin & Company, 419 Washington Ave., Houston, Tex.
Fisher Governor Co., Marshalltown, Iowa.
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Johns-Manville Corporation, 292 Madison Ave. at 41st St., New York, N. Y.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.
W. H. Nicholson & Co., 132 Oregon St., Wilkes-Barre, Pa.
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Providence Engineering Corp., Providence, R. I.
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Volz Engineering Corporation, 3732-3734 East 7th St., Long Beach, Calif.
The Williams Gauge Co., 1620 Pennsylvania Ave., N. S., Pittsburgh, Pa.

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Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.
Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.
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Henry Vogt Machine Co., Louisville, Ky.

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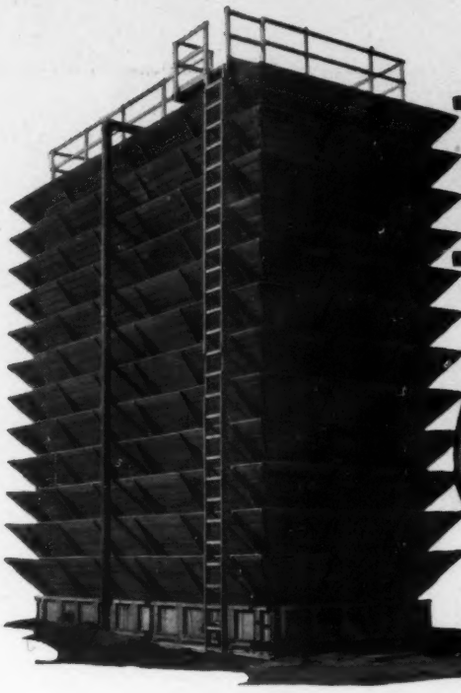

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Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

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Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

The Wm. Powell Co., Cincinnati, Ohio.

Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

VALES, Ball Check

Darling Valve & Mfg. Co., Williamsport, Pa.

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American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.

Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.

Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.

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Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.

Northern Pump Co., Minneapolis, Minn.

The Ohio Injector Co., 247 Main St., Wadsworth, Ohio.

H. A. Paine Co., 1308-9 Second Nat'l Bank Bldg., Houston, Tex.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.

The Wm. Powell Co., Cincinnati, Ohio.

VALVES, Breather

Eimer & Amend, 18th to 19th St., Third Ave., New York, N. Y.

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

The Oil Conservation Company, 877 Addison Road, Cleveland, Ohio.

VALVES, By-pass

C. F. Braun & Co., Alhambra, California.

Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.

Kennedy Valve Mfg. Co., Elmira, New York.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

The Ohio Injector Co., 247 Main St., Wadsworth, Ohio.

Reading Steel Castings Co., Bridgeport, Conn.

Henry Vogt Machine Co., Louisville, Ky.

Westcott Valve Co., East St. Louis, Ill.

VALVES, Check

Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.

Darling Valve & Mfg. Co., Williamsport, Pa.

Illinois Malleable Iron Co., 1801-1825 Diversey Parkway, Chicago, Ill.

Kennedy Valve Mfg. Co., Elmira, New York.

Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.

Ludlow Valve Mfg. Co., Kansas City, Mo.

Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

The Ohio Injector Co., 247 Main St., Wadsworth, Ohio.

Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.

Henry Vogt Machine Co., Louisville, Ky.

Westcott Valve Co., East St. Louis, Ill.

VALVES, Check, Horizontal

American Valve Co., Mansion St., Coxsackie, N. Y.

VALVES, Check Swing

American Valve Co., Mansion St., Coxsackie, N. Y.

Darling Valve & Mfg. Co., Williamsport, Pa.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

GOLDEN - ANDERSON VALVE SPEC. CO., 1228 FULTON BLDG., PITTSBURGH, PA.

Automatic valves for steam and water service.

Harrisburg Pipe & Pipe Bending Co. of Texas, Inc., P. O. Box 42, Houston, Texas.

Hughes Tool Co., 300 Hughes St., Houston, Texas.

Kennedy Valve Mfg. Co., Elmira, New York.

Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.

Ludlow Valve Mfg. Co., Kansas City, Mo.

Ohio Injector Co., Wadworth, Ohio.

The Wm. Powell Co., Cincinnati, Ohio.

Reading Steel Castings Co., Bridgeport, Conn.

Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.

Henry Vogt Machine Co., Louisville, Ky.

Westcott Valve Co., East St. Louis, Ill.

VALVES, Combined Back Pressure and Relief

George B. Allan & Co., Simpson Building, Dallas, Texas.

J. A. Campbell, P. O. Box 669, Long Beach, Calif.

A. W. Cash Co., Box 135, Decatur, Ill.

Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.

Fisher Governor Co., Marshalltown, Iowa.

Kennedy Valve Mfg. Co., Elmira, New York.

Mason Regulator Co., Adams & Medway Sts., Boston, Mass.

Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.

H. A. Paine Co., 1308-9 Second National Bank Bldg., Houston, Texas.

Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.

Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.

Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

VALVES, Control

The Bristol Co., Waterbury, Conn.

Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.

Everlasting Valve Co., Jersey City, N. J.

Gorton Heating Corporation, 96 Liberty Street, New York, N. Y.

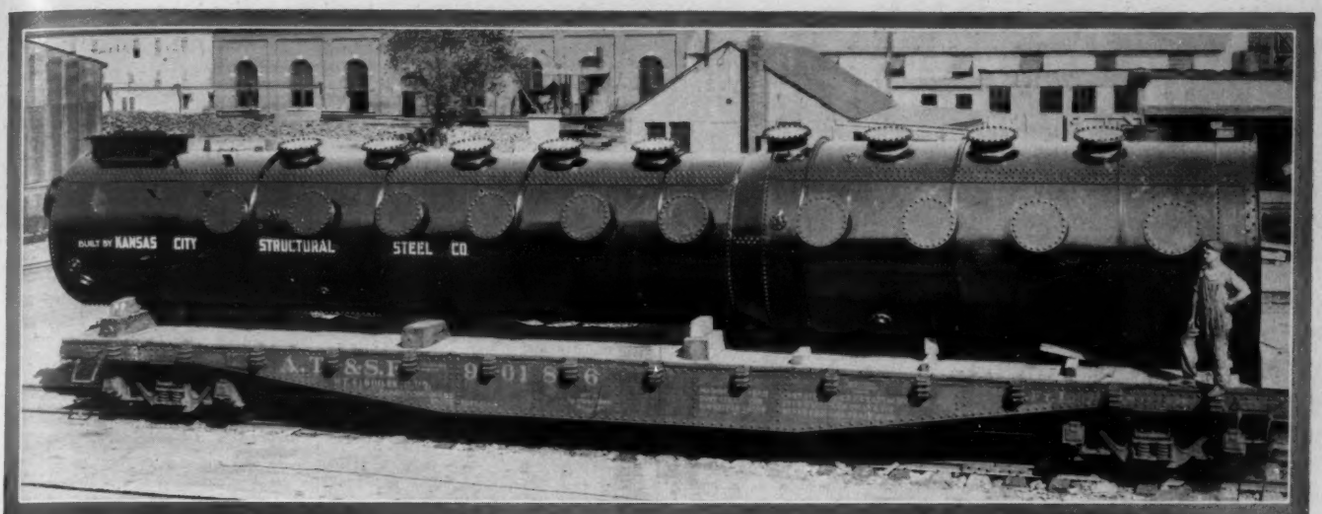
Fisher Governor Co., Marshalltown, Iowa.

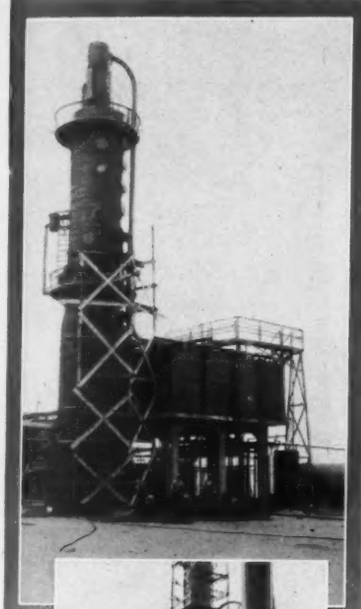
Greene Brothers, 524-8 Seventh St., Wichita Falls, Texas.

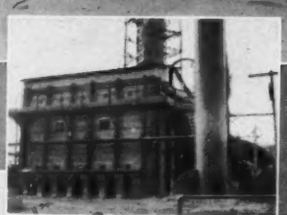
Kennedy Valve Mfg. Co., Elmira, New York.

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

National Airoil Burner Company, Inc., 1327 Gira d Avenue, Philadelphia, Pa.





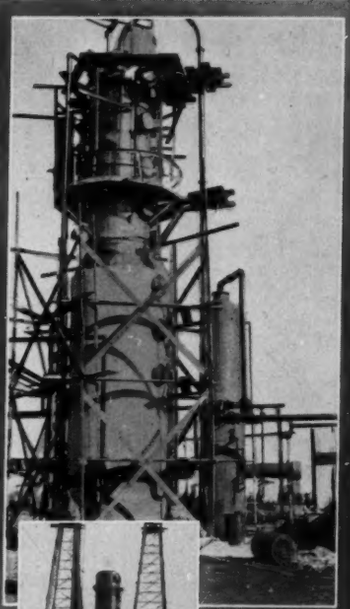


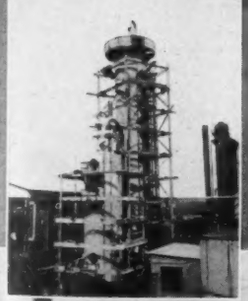
Bubble Towers

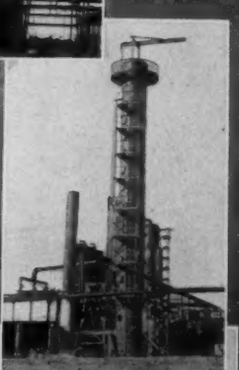
Our results in increasing yields of the more valuable products as well as reducing operating costs are evidenced most conclusively by the fact that eighty per cent of our business is from repeat orders.

Our installations cover the industry and we will be pleased to have you inspect any of them and see for yourself the results obtained and how they stand up under hard service.

Our engineers are at your service and we will consider it a privilege to be permitted to send an engineer to your plant at our own expense to determine if your recoveries can be increased or your operating costs reduced, and what equipment would be necessary for this most desirable result.

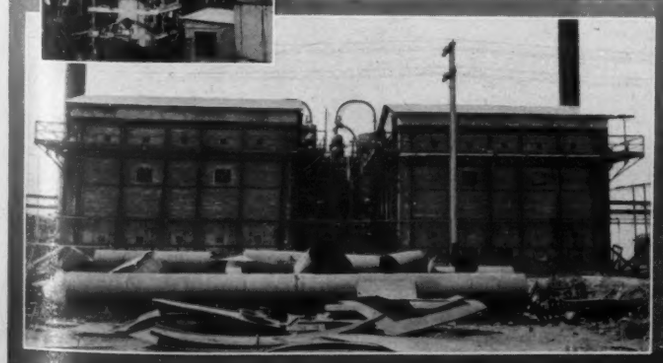


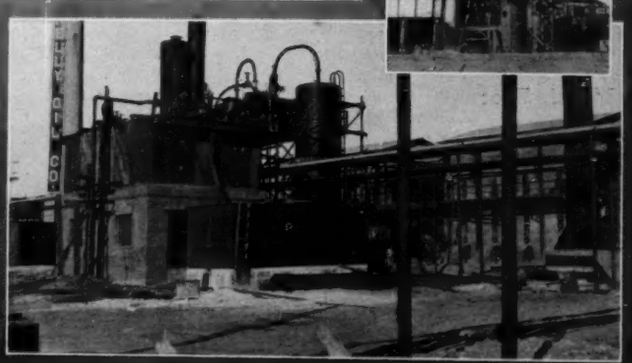




THE WINKLER-KOCH ENGINEERING CO.

Consulting and Construction Engineers
429 First National Bank Bldg.,
WICHITA, KANSAS





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Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
The Wm. Powell Co., Cincinnati, Ohio.
Reading Steel Castings Co., Bridgeport, Conn.
Taylor Instrument Companies, Rochester, N. Y.
Henry Vogt Machine Co., Louisville, Ky.

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WESTCOTT VALVE CO., EAST ST. LOUIS, ILL.
Westcott Double Purpose Valves made of high chrome steel with stainless steel trimmings throughout for high temperature cracking still and pump connections, 600°-600 lb. pressure, 900°-900 lb. pressure, sizes 4"-6"-8" and up.

VALVES, Drop-Forged

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VALVES, Electrically Operated

The Bristol Co., Waterbury, Conn.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
GOLDEN - ANDERSON VALVE SPEC. CO., 1228 FULTON BLDG., PITTSBURGH, PA.
Automatic valves for steam and water service.
Kennedy Valve Mfg. Co., Elmira, New York.
Ludlow Valve Mfg. Co., Kansas City, Mo.
MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
MERCON REGULATOR COMPANY, 53 W. JACKSON BLVD., CHICAGO, ILL.
See description under REGULATORS, Pressure.
Reading Steel Castings Co., Bridgeport, Conn.
Taylor Instrument Companies, Rochester, N. Y.

VALVES, Electrically Operated Whistle

Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.

VALVES, Float

Atlas Valve Co., 282-286 South St., Newark, N. J.
H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.
Fisher Governor Co., Marshalltown, Iowa.
GOLDEN - ANDERSON VALVE SPEC. CO., 1228 FULTON BLDG., PITTSBURGH, PA.
Automatic valves for steam and water service.
Arthur Harris & Co., 212 N. Curtis St., Chicago, Ill.
Ludlow Valve Mfg. Co., Kansas City, Mo.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
Neilan, Schumacher & Co., 641-651 Santa Fe Ave., Los Angeles, Calif.
Pitts & Kitts Mfg. & Supply Co., 91 7th Ave., New York, N. Y.
Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

VALVES, Foot

Columbian Steel Tank Co., 1405-1625 West 12th St., Kansas City, Mo.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.

VALVES, Forged Steel

Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.
DARLING VALVE & MFG. CO., WILLIAMSPORT, PA.
For high pressure and high temperature and other important service.
The Hydraulic Press Mfg. Co., 20 East Broad, Columbus, Ohio.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.

VALVES, Gas

American Valve Co., Mansion St., Coxsackie, N. Y.
Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.
Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.
Darling Valve & Mfg. Co., Williamsport, Pa.
Everlasting Valve Co., Jersey City, N. J.
Homestead Valve Mfg. Co., Inc., Homestead, Pa.
Kennedy Valve Mfg. Co., Elmira, New York.
Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.
Ludlow Valve Mfg. Co., Kansas City, Mo.
MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.
Northern Pump Co., Minneapolis, Minn.
The Wm. Powell Co., Cincinnati, Ohio.
Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.

VALVES, Gasoline Relief

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
Crosby Steam Gauge & Valve Co., No. 10 Roland St., Boston, Mass.
Kunkle Valve Company, 121 N. Clinton St., Fort Wayne, Ind.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.
Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.
Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.
Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

VALVES, Gate

American District Steam Co., North Tonawanda, N. Y.
Geo. B. Allan & Co., Simpson Building, Dallas, Texas.
American Valve Co., Mansion St., Coxsackie, N. Y.
DARLING VALVE & MFG. CO., WILLIAMSPORT, PA.
We manufacture gate valves in all sizes and types for the different branches of the oil and gas industry.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
EVERLASTING VALVE CO., 1 EXCHANGE PLACE, JERSEY CITY, N. J.
The Everlasting Valve cannot be shut too tight and is never injured in closing.
Gorton Heating Corporation, No. 96 Liberty St., New York, N. Y.
Harrisburg Pipe & Pipe Bending Co., Houston, Texas.
Hughes Tool Co., 300 Hughes St., Houston, Texas.
Illinois Malleable Iron Company, 1801 Diversey Blvd., Chicago, Ill.
Jarecki Manufacturing Co., St. Louis, Mo.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kerotest Mfg. Co., 2525 Liberty Ave., Pittsburgh, Pa.
Ludlow Valve Mfg. Co., Kansas City, Mo.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Ohio Injector Co., Wadworth, Ohio.
Philadelphia Steel & Iron Co., Commercial Trust Bldg., Philadelphia, Pa.
Wm. Powell Co., Cincinnati, Ohio
Reading Steel Castings Co., Bridgeport, Conn.
Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.
Henry Vogt Machine Co., Louisville, Ky.
WESTCOTT VALVE CO., EAST ST. LOUIS, ILL.
Standard and extra heavy gate valves for general refinery use.

VALVES, Globe

American Valve Co., Mansion St., Coxsackie, N. Y.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Homestead Valve Mfg. Co., Inc., Homestead, Pa.
Hughes Tool Co., 300 Hughes St., Houston, Texas.
Kennedy Valve Mfg. Co., Elmira, New York.
The Ohio Injector Co., 247 Main St., Wadsworth, Ohio.
Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.
The Wm. Powell Co., Cincinnati, Ohio.
Reading Steel Castings Co., Bridgeport, Conn.
Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.
Henry Vogt Machine Co., Louisville, Ky.

VALVES, Globe, Angle and Cross

American Valve Co., Mansion St., Coxsackie, N. Y.
George B. Allan & Co., Simpson Building, Dallas, Texas.
H. Belfield Co., 435 N. Broad St., Philadelphia, Pa.
CENTRAL VALVE MFG. CO., 231E. 95TH ST., CHICAGO, ILL.
"Replate", "Multiplate" and "Perfection" brass valves are made for all services up to 300 lb. pressure and 550°F. temperature. "Replate" and "Multiplate" types are kept perpetually tight by an occasional quick and cheap replacement of the contracting parts, while the "Perfection" type is continuously "self grinding" to a perfect seat.
Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.
Jarecki Manufacturing Co., St. Louis, Mo.
Kennedy Valve Mfg. Co., Elmira, New York.
The Ohio Injector Co., 247 Main St., Wadsworth, Ohio.
Philadelphia Steel & Iron Co., 1008 Commercial Trust Bldg., Philadelphia, Pa.
The Wm. Powell Co., Cincinnati, Ohio.
Reading Steel Castings Co., Bridgeport, Conn.
Henry Vogt Machine Co., Louisville, Ky.

VALVES, Hose

American Valve Co., Mansion St., Coxsackie, N. Y.
Darling Valve & Mfg. Co., Williamsport, Pa.
Everlasting Valve Co., Jersey City, N. J.
Kennedy Valve Mfg. Co., Elmira, New York.
Ludlow Valve Mfg. Co., Kansas City, Mo.
The Wm. Powell Co., Cincinnati, Ohio.
Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.

VALVES, Hot Oil and Tar

Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.
Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.
Darling Valve & Mfg. Co., Williamsport, Pa.
ECKENROTH VALVE & MANUFACTURING CO., 158 CONARROE ST., PHILADELPHIA, PA.
Riley Power Equipment Co., 49 East Wells St., Milwaukee, Wisconsin, Sole Distributors, Eckenroth Automatic Reseating Blowoff Valve. Maintain their own seating surfaces by exclusive patented automatic reseating action built into the valve. Semi-steel for pressures up to 250 pounds. Cast steel for high pressures. Eliminates maintenance and repairs, gives continuous tightness. Manufactured and guaranteed by Eckenroth Valve & Mfg. Co., Philadelphia, Pa.

Everlasting Valve Co., Jersey City, N. J.
Homestead Valve Mfg. Co., Inc., Homestead, Pa.
Hughes Tool Co., 300 Hughes St., Houston, Texas.
Judson Governor Co., Rochester, N. Y.
Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.
Lake Erie Manufacturing Co., Inc., 192-198 Chicago St., Buffalo, N. Y.
Ludlow Valve Mfg. Co., Kansas City, Mo.
MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.
Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.
National Airoil Burner Company, Inc., 1327 Gira d Avenue, Philadelphia, Pa.
Northern Pump Co., Minneapolis, Minn.
Reading Steel Castings Co., Bridgeport, Conn.
Henry Vogt Machine Co., Louisville, Ky.
Westcott Valve Co., East St. Louis, Ill.

VALVES, Hydraulic

Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
Everlasting Valve Co., Jersey City, N. J.
Homestead Valve Mfg. Co., Inc., Homestead, Pa.
The Hydraulic Press Mfg. Co., 20 East Broad, Columbus, Ohio.
Kennedy Valve Mfg. Co., Elmira, New York.
Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.
The Ohio Injector Co., 247 Main St., Wadsworth, Ohio.
Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.
Westcott Valve Co., East St Louis, Ill.

VALVES, Internal

A. Y. McDonald Mfg. Co., Dubuque, Iowa.

VALVES, Lead Lined

MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

VALVES, Lever

American Valve Co., Mansion St., Coxsackie, N. Y.
Darling Valve & Mfg. Co., Williamsport, Pa.
Everlasting Valve Co., Jersey City, N. J.
Fisher Governor Co., Marshalltown, Iowa.
Kennedy Valve Mfg. Co., Elmira, New York.
Ludlow Valve Mfg. Co., Kansas City, Mo.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
National Airoil Burner Company, Inc., 1327 Gira d Avenue, Philadelphia, Pa.
Northern Pump Co., Minneapolis, Minn.
The Wm. Powell Co., Cincinnati, Ohio.
Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.
Titusville Iron Works Co., Titusville, Pa.

VALVES, Lever Angle

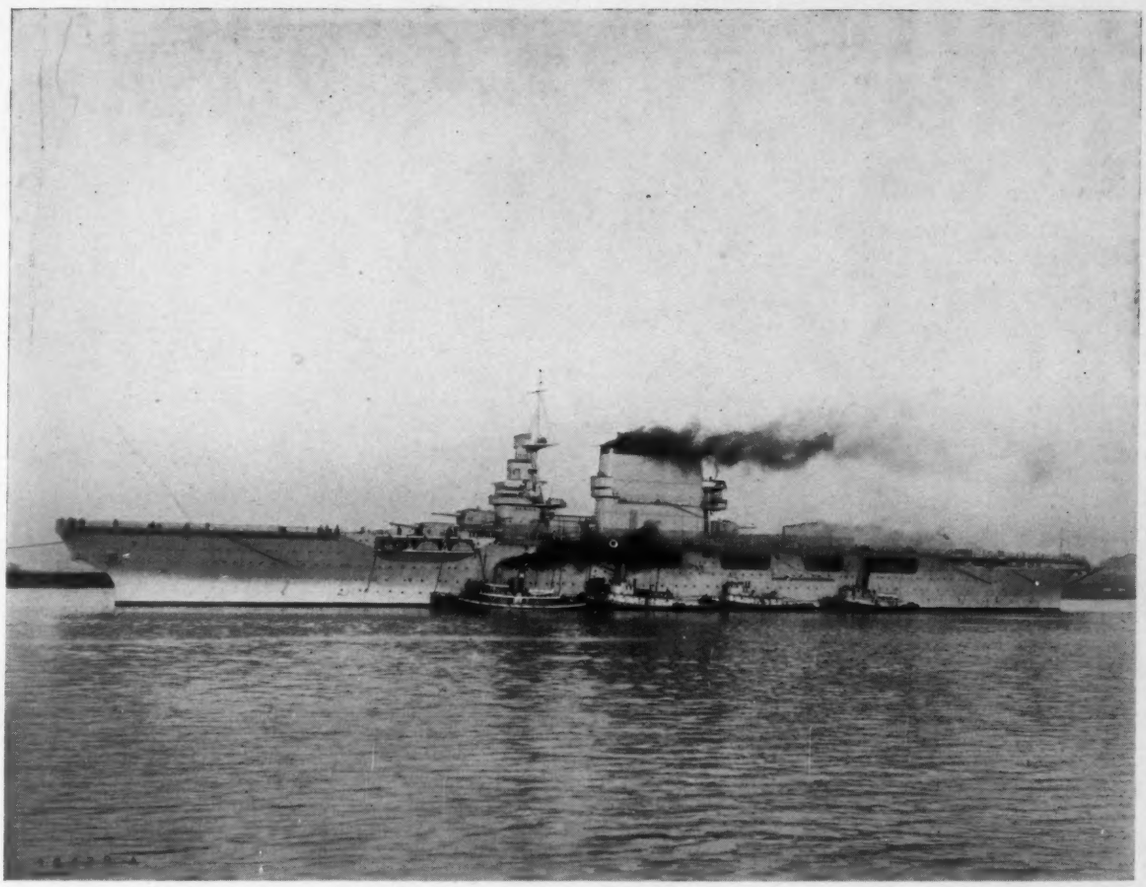
Darling Valve & Mfg. Co., Williamsport, Pa.
Everlasting Valve Co., Jersey City, N. J.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.

VALVES, Lubricated

Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.
Homestead Valve Mfg. Co., Inc., Homestead, Pa.
MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.

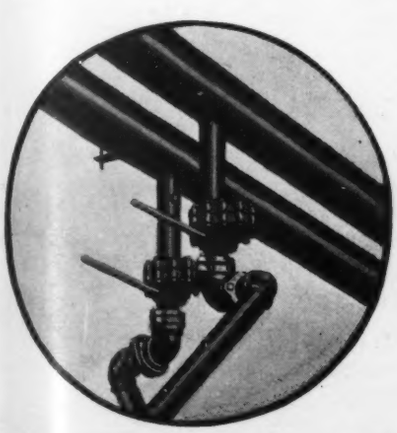
THE EVERLASTING VALVE

Was Chosen for Handling "Gasoline" on Airplane Carriers "Lexington" and "Saratoga", Supplying Air Craft



GASOLINE TYPE

For Light Volatile Liquids, Light and Heavy Oils—Oils of All Kinds.



The *Seat* of the Everlasting Valve is a table which supports the *Disc* throughout the full path of travel. The *Spring* and Pressure hold the disc against the seat at all times. Self-cleaning—the *Disc* sweeping grit or particles and deposit of any kind from the valve seat.

The Everlasting valve (Gasoline Type) is a quick opening and quick closing valve. It has no stuffing box and therefore requires no packing. It absolutely holds tight in gasoline service.

The Everlasting is also made for Acid Service, air lines, hot oil, etc. In boiler blow-off service it is guaranteed absolutely drop tight for two years.

Made in Iron, Cast Steel, Brass and acid resisting metals.

Write for our Valve Booklet.

EVERLASTING VALVE COMPANY, Jersey City, N.J.

MADE IN CANADA BY EVERLASTING VALVE CO., LTD., TORONTO.

MERCO NORDSTROM VALVE COMPANY, 121 SECOND ST., SAN FRANCISCO, CALIFORNIA.
For air, acids, alkalis, gasoline, kerosene, distillate, benzol, tar, boiler blow-off, ammonia, ammonium nitrate, gas, etc. For all pressures and temperatures.
Northern Pump Co., Minneapolis, Minn.

VALVES, Mixing

POWERS REGULATOR CO., 2776 GREENVIEW AVE., CHICAGO, ILL.
Mixing Hot and Cold Water or Steam and Cold Water. Capacities 3 to 1,700 gallons per minute. To deliver at any temperature desired.

VALVES, Needle

Darling Valve & Mfg. Co., Williamsport, Pa.
Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
Metric Metal Works, Erie, Pa.
The Ohio Injector Co., 247 Main St., Wadsworth, Ohio.
Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

VALVES, Non-Freeze

WESTCOTT VALVE CO., EAST ST. LOUIS, ILL.
Manufacturers of the Hutching Non Freeze Valves and swing pipe connections and automatic closing sample valves for stills.

VALVES, Non-Return

H. Belfield Co., 435 N. Broad St., Philadelphia, Pa
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GOLDEN - ANDERSON VALVE SPEC. CO., 1228 FULTON BLDG., PITTSBURGH, PA.
Automatic valves for steam and water service.
Kennedy Valve Mfg. Co., Elmira, New York.
Maintenance Engineering Corp., 2000 Harrington St., Houston, Texas.
The Wm. Powell Co., Cincinnati, Ohio.

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EVERLASTING VALVE CO., JERSEY CITY, N. J.
The Everlasting Valve was selected by the U. S. Navy to handle gasoline on Aeroplane Carriers "Lexington" and "Saratoga."
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MacGregor Valve Co., 3560 Chouteau Ave., St. Louis, Mo.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.
The Wm. Powell Co., Cincinnati, Ohio.
Smith Separator Company, Chestnut & Smith Corp. Bldg., Tulsa, Oklahoma.
Westcott Valve Co., East St. Louis, Ill.

VALVES, Oxygen

Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa.
Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.
Henry Vogt Machine Co., Louisville, Ky.

VALVES, Piston

Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.

VALVES, Plug

Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.
Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa.
Homestead Valve Mfg. Co., Inc., Homestead, Pa.
Judson Governor Co., Rochester, N. Y.
MacGregor Valve Co., 3560 Chouteu Ave., St. Louis, Mo.
Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.
National Airoil Burner Company, Inc., 1327 Girard Avenue, Philadelphia, Pa.
Northern Pump Co., Minneapolis, Minn.

VALVES, Lubricated Plug

Barco Manufacturing Co., 1801-1815 Winnemac Ave., Chicago, Ill.
Homestead Valve Mfg. Co., Inc., Homestead, Pa.
MacGregor Valve Co., 3560 Chouteu Ave., St. Louis, Mo.
MERCO-NORDSTROM VALVE CO., PETROLEUM BLDG., HOUSTON, TEXAS.
"It Won't Stick."
"It Won't Leak."
Mueller Co., Decatur, Ill.
Northern Pump Co., Minneapolis, Minn.

VALVES, Pop Safety

American Schaeffer & Budenberg Corp., Berry & S. 5th Sts., Brooklyn, N. Y.
Crosby Steam Gage & Valve Co., 10 Roland St., Boston, Mass.
Eclipse Fuel Engineering Co., 814 S. Main St., Rockford, Ill.
Fisher Governor Co., Marshalltown, Iowa.
Kunkle Valve Company, 121 N. Clinton St., Fort Wayne, Ind.
Pittsburgh Equitable Meter Co., 400 Lexington Ave., Homewood, Pittsburgh, Pa.
The Wm. Powell Co., Cincinnati, Ohio.
Scott Valve Mfg. Co., 3963 McKinley Ave., Detroit, Mich.
Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

VALVES, Pump

George B. Allan & Co., Simpson Building, Dallas, Texas.
Furness Bros. Company, 1615 West Walnut St., Chicago, Ill.
LAKE ERIE MANUFACTURING CO., INC., 192-198 CHICAGO ST., BUFFALO, N. Y.
Our Special Ideal Pump Valves are especially made for pumping oil, either mineral or vegetable, gasoline, naphtha, benzol, turpentine, ammonia, creosote, lye, potash, molasses and other liquids that quickly destroy rubber or composition valves.
The material from which Ideal Special Valves are manufactured is the same as that used for our regular type plain valves before undergoing special treatment for use in water and is positively uneffected by any of the liquids mentioned.
Valves made from this material are practically indestructible where seats in pump are in good condition, and will give years of service without renewals.
Send for booklet giving complete description and prices.
Mason Regulator Co., Adams & Medway Sts., Boston, Mass.
A. Y. McDonald Mfg. Co., Dubuque, Iowa.
Merco Nordstrom Valve Company, 121 Second St., San Francisco, California.
National Transit Pump & Machine Co., 19 North Petroleum St., Oil City, Pa.
New York Belting & Packing Co., 91 and 93 Chambers St., New York, N. Y.
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See description under REGULATORS, Pressure.
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Westcott & Greis, 429 First Nat'l Bank Bldg., Tulsa, Oklahoma.

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Brooks Engineering Corporation, 1325 Maple Avenue, Los Angeles, Calif.
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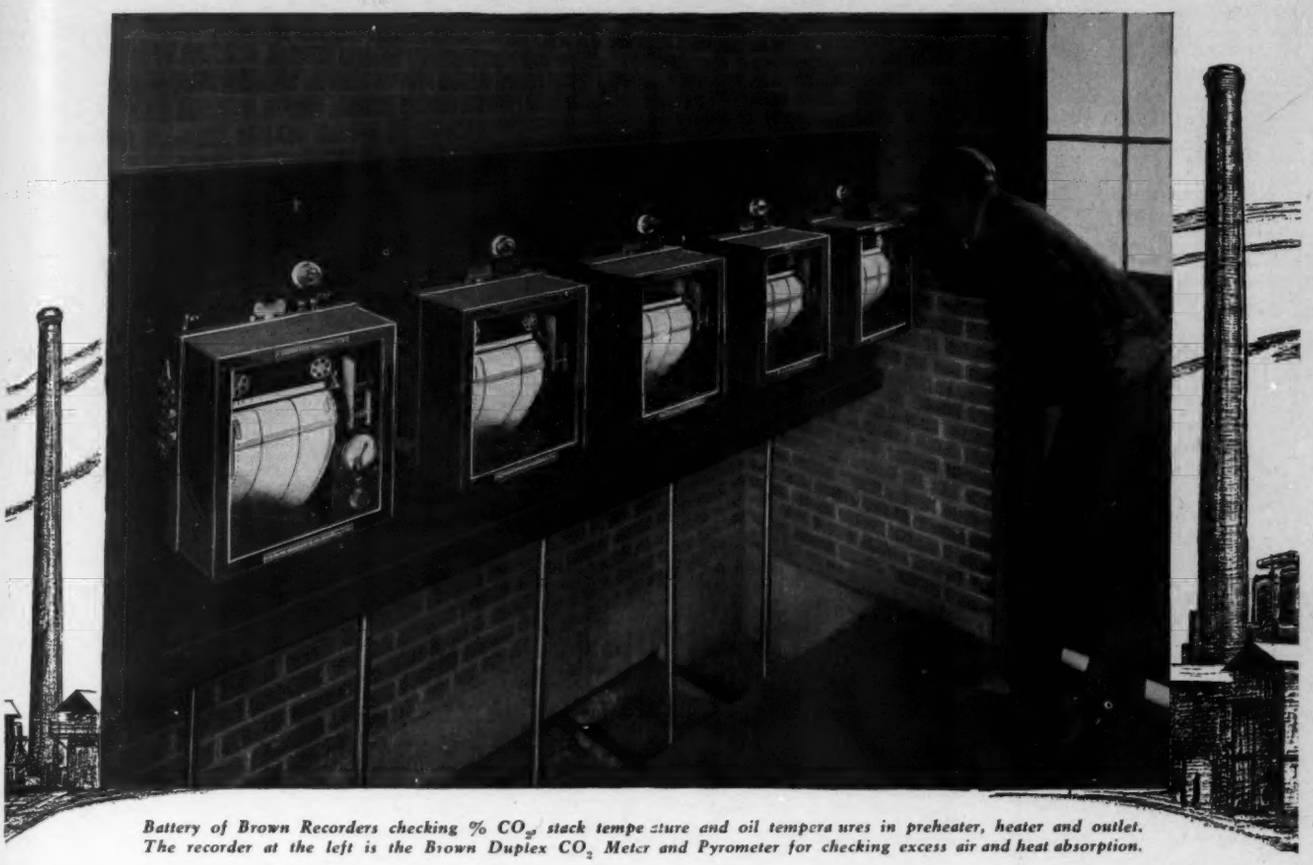

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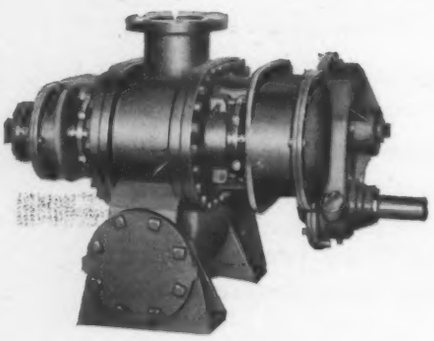

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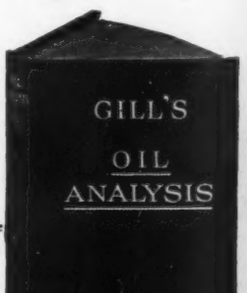

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The float is made of chrome-nickel steel, heat-treated, welded and nickel-plated. It is said to be non-collapsible up to 1000 pounds.

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Two inlets are furnished on Nicholson traps. Either one may be used for the gasoline inlet, the other serving as a vent carrying the volatile gases that come over with the liquid, back to the accumulator.

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Hills-McCanna Company, 2349-59 Nelson Street, Chicago, announces the perfection of the Young Outlet Valve, Class "A", for use on tank cars.

The Bureau of Standards in cooperation with the joint committee of the American Railway Association, American Petroleum Institute, and American Railway Car Institute, has finished a series of tests to pass on and classify tank car bottom outlet valves, and the Young Valve was approved for unlimited service.

Salient features of the valve are: the piston raises and lowers by means of a threaded stem operating through a threaded hole in the top of the valve housing or cage. Closure is effected between the upper end of the piston and wall by means of several layers of packing set into close contact with the piston and is protected from rust or scale by the skirt of the hollow piston. No liquid passes over the packing at any stage of the opened or closed position. Construction is such that no damage to the valve takes place if the outlet leg is broken off in transit, and no leakage will occur in the event of such an accident. A supplementary full metallic closure to operate in emergency is incorporated in the construction.

The valve can be used for replacing valves on cars now in existence. Tools have been designed for machining the outlet leg in place in the car, obviating the necessity of removal or replacement of the existing outlet leg.

Further information may be secured from the company, by request.

New Bristol Recorder

THE BRISTOL COMPANY

A new recorder and contracting controller is now being offered by the Bristol Company. This combines in one case the features of a rugged recorder and thermometer controller which offers a more compact outfit than separate instruments.

The equipment consists of a single pen recording system with controller system and scale mounted directly above it. The recording pen and moving contact of the controller are each actuated by separate pressure elements which are exactly alike in construction. These elements are connected through one capillary tube to the sensitive bulb.

This novel recorded controller is arranged for a contact capacity of 1000 watts by equipping it with self-contained automatic switches. Terminals are supplied for making easy connections to line and control apparatus through conduit. All internal circuits are heavily insulated.

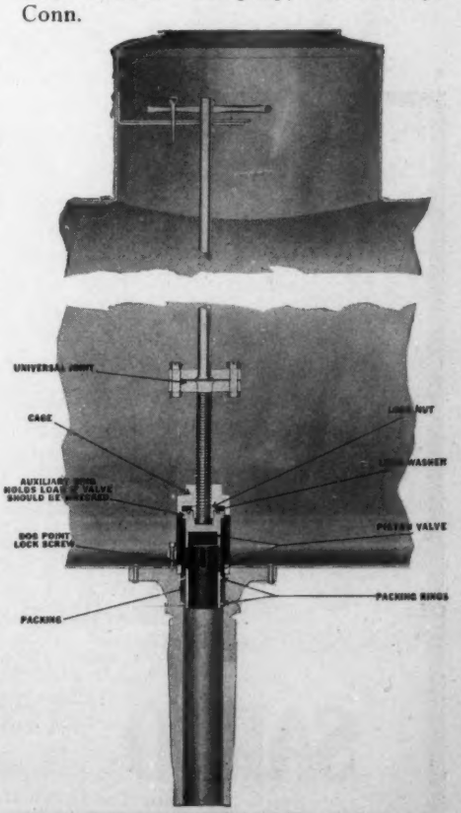
To use, it is only necessary to set the control to the desired temperature by moving an index pointer over a scale to the exact degree to be controlled. This index pointer is very long and it is thus possible to adjust it accurately and easily.

Zero adjusters are provided for both recorder and controller pressure elements. They are not easily tampered with by unauthorized persons because they can be moved only after being unlocked with a screw driver.

The case is made of sheet steel and is supplied with a glass over the chart and controller scale. It is equipped with heavy lugs at top and bottom for mounting to wall or other support.

The large current carrying capacity of this controller makes it possible to adapt the instrument to many control applications without the use of relays. Bristol's motor operated and solenoid controller valves may be connected directly to the terminal. Also for electric heating control, main line switches may be operated without the addition of relays.

More details will be furnished by The Bristol Company, Waterbury, Conn.



Young Outlet Valve.

GRISCOM-RUSSELL ENLARGES

Massillon, Ohio.—Additional manufacturing facilities have been secured by the Griscom-Russell Company, here, through the purchase of the major portion of Russell and Company's plant adjoining The Griscom-Russell Company's property.

The newly acquired buildings include machine shops, tool room, boiler shop, sheet metal and coil shop, pattern shop, carpenter shop and many other departments which have been re-arranged and equipped throughout with the most modern types of precision machinery and special apparatus. In conjunction with the original Griscom-Russell machine shops, boiler shops, erecting and testing floors and other departments, the combined plant now affords exceptionally complete facilities for speedy, accurate and economical production of the Griscom-Russell products which include evaporators, feed water heaters, air coolers and heaters, oil coolers, heat exchangers, condensers and other types of heat transfer apparatus.

The Griscom-Russell property now totals 15½ acres, situated on the main line of the Pennsylvania Railroad. The plant is also served by the Baltimore and Ohio and the Wheeling and Lake Erie. The Griscom-Russell Company, the successor of an earlier company founded in 1867, has been located at Massillon since 1812, moving there after outgrowing the facilities of its former plant in Jersey City, New Jersey.

KENNEDY VALVE OFFICES

The Kennedy Valve Manufacturing Company of Elmira, New York, announces the election of Matthew E. Kennedy as president and treasurer; J. Carroll Kennedy as vice-president and secretary, and Clarence H. Kennedy as vice-president and general sales manager.

These officials are all sons of the late Daniel Kennedy, who founded the business over 50 years ago, and was president until his death last January. Matthew E. Kennedy has been with the company for approximately 32 years, and for many years has been treasurer and general manager. J. Carroll Kennedy came with the company about 19 years ago and as works manager, has for nine years been in charge of production. He will continue these duties. Clarence H. Kennedy, who has been with the company about 16 years, has acted as general sales manager for the past eight years.

The previous business policies of the company will be maintained under the present management.

The Kennedy line includes steel, iron-body and bronze valves, fire hydrants, water gates, cast-iron flanged fittings, and malleable iron and bronze screwed fittings.

The Vinson-Canter Company has recently been organized to handle a line of power plant, refinery, and natural gasoline plant equipment. B. W. Vinson has been in the equipment business in Tulsa for over seven years. He has handled Copes Feed Water Regulators, Tracyfiers, and other lines. V. C. Canter is well known in the natural gasoline field, having been connected with the development and sales of Charcoal absorption gasoline plants for several years. Mr. Canter is not giving up his connection with the Gasoline Recovery Corporation as their Mid-Continent sales representative in charge of the Tulsa branch office.

In addition to the Copes Regulators and Tracyfiers the new company will handle Barco Lubricated Plug Valves and Flexible Joints, Nicholson Steam and Gasoline Traps and steam specialties, Blaw-Knox Electroforged Grating, Air Preheaters, and Standard Buildings.

The address of the Vinson-Canter Company at Tulsa is 422 Wright Building.

CORK BULLETIN

Cork Import Corporation, 345-349 West 40th Street, New York, has issued bulletins covering corkboard insulation for roofs, walls and floors, and also for insulating cold lines. Copies of the bulletins may be had from the company.

Why guess at temperatures

—when one mistake can cost many times more than this automatic regulator

THE man trying to watch and control temperature may keep it right four times out of five—perhaps nine times out of ten—but sooner or later he is sure to slip up—and every time he does a batch of expensive material is either spoiled or damaged.

Why depend on mere guessing—on hit or miss uncertainty, when you can have absolute certainty?

A single batch of spoiled material, a single process gone wrong through the uncertainty of guessing, will frequently amount to several times the cost of a Sarco Temperature Regulator—an automatic heat control that is absolutely guaranteed to be accurate and dependable under all conditions.

Entirely self-contained and self-operating—operated by the simple and sure expansion and contraction of an extremely sensitive liquid. Instantly responsive to the slightest variation in temperature—giving a perfectly graduated control. No electricity, no compressed air or water, no outside attachment or outside aid of any character.

Because of its simplicity, its elimination of complicated attachments and other involved mechanisms, it costs less than any other regulator—and is more easily installed.

Operates on gas, steam or hot water heat. Can be supplied to control temperature in any kind of manufacturing process. Also for control of room temperature, hot water temperature, etc.

Sold on 30 days' free trial. Write for Booklet S-60.

SARCO CO., Inc.

183 Madison Ave., New York City

Boston Buffalo Cleveland Chicago Detroit Philadelphia St. Louis Pittsburgh Peacock Bros., Montreal

SARCO Temperature Regulator

Mosher Completes New Fabricating Plant

Dallas, Texas.—Mosher Steel and Machinery Company recently completed a new factory on the Maple Avenue road. The plant is located on a 37-acre site and embraces a general office building as well as concrete bar fabricating department, receiving and shipping runways and warehouses.

The company's ornamental shop, machine and blacksmith shop, foundry and pattern works are being removed to the new location from the old factory site on South Lamar Street.

The Mosher Steel and Machinery Company was started in Dallas in 1885 as a small machine shop with about five men employed. About 650 men are now employed by the company. In 1887 the plant was moved to larger quarters on Ross Avenue and Carter Street and a foundry department was added and in 1890 the plant was again moved to Lamar Street and Santa Fe railway. In 1907 a plant was built in Houston that is operated today under the name of the Houston Structural Steel Company, serving the Gulf Coast and South Texas territory.

The new plant on Maple Avenue road has been necessary by the continued growth and expansion in the company's business

The company manufactures special refinery and natural gasoline plant equipment for the oil industry, steel buildings for industrial purposes of all kinds, plate work, concrete reinforcing bars, gray iron and brass castings, steam stills, agitators and other products.

ELLIOTT COMPANY BULLETINS

Elliott Company, Jeanette, Pennsylvania, has published several new bulletins describing its products. These bulletins are as follows:

N-8 is a 16-page bulletin describing vacuum, atmospheric, and pressure type Elliott power plant deaerators.

S-8 is an eight-page bulletin describing the use, operation, and construction of Elliott double automatic triple duty valves, giving dimensions, specifications, etc.

H-3, H-4 and H-5 are four-page leaflets covering Elliott forms BP, CP and DP turbines for mechanical drive. These bulletins are printed in two colors and are illustrated.

N-9 is an eight-page bulletin illustrating and describing the Elliott cartridge type desuperheater.

Copies of any or all of the bulletins may be had by writing the company.

FIRMS CONSOLIDATE

The Celite Company of Los Angeles announces that they have purchased the plant and property of the National Magnesia Manufacturing Company at Redwood City, about 25 miles south of San Francisco. The business of the latter Company will be continued under the name of the National Magnesia Company. Both The Celite Company and the National Magnesia Manufacturing Company started in business in 1912 and since that time have built up businesses of national and international scope.

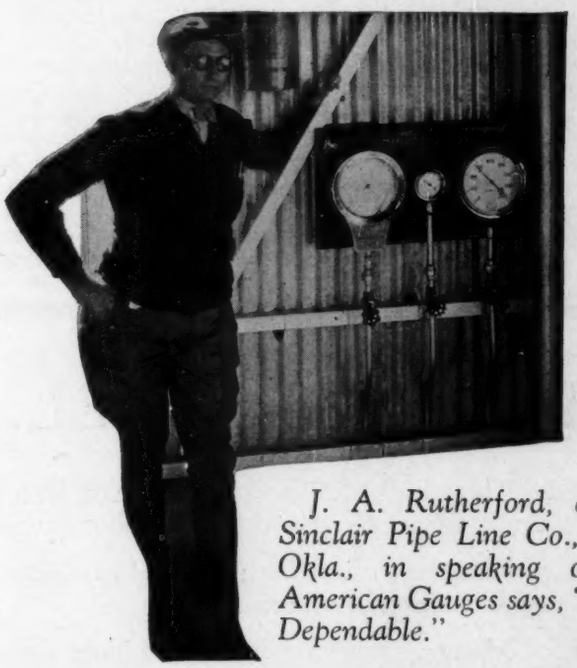
The manufacturing plant of The Celite Company is located at White Hills, (near Lompoc) California. This is said to be the largest plant in the world engaged in the manufacture of diatomaceous earth products (including heat insulating materials, filter-aids, admixtures for concrete and many grades of mineral fillers).

The business at Redwood City includes the manufacture of magnesia, asbestos and diatomaceous earth insulating materials. This business will be continued and the scope of its service enlarged under the new name, National Magnesia Company.

DESUPERHEATERS

Schutte and Koerting Company, Philadelphia, announce publication of a new bulletin on desuperheaters. Steam required for large turbines and engines cannot be taken directly from high temperature steam headers, and where a plant consumes enough power to make the generation of superheated steam advisable, saturated steam can be obtained only by providing separate boilers or by desuperheating a portion of the high temperature steam. Schutte and Koerting desuperheaters are especially designed for this service. Bulletin No. 6-D gives all the details on this type of equipment and copies may be obtained from the manufacturer by request.

"They're dependable"



J. A. Rutherford, engineer, Sinclair Pipe Line Co., Stroud, Okla., in speaking of these American Gauges says, "They're Dependable."

The engineer prefers American Gauges and Thermometers because he knows he can rely upon their long service and constant accuracy.

Write for the following:

Gauge Catalog A-19
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Steam Trap Catalog S-19
Tachometer Catalog J-19

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Abstracts of Technical Literature

Of Particular Interest to the Plant Operator

Distillation

INVESTIGATION of the Distilling Process of a Gasoline Stripping Tube Plant. Zakharenko and Mirzkuliev.—(Neftyanoe Khozyaistvo 13, 446-54 (1927); *C. A. Vol. 22, No. 8, p.* 1465). Very complete operating charactertistics are given of an experimental stripping plant, consisting of a pipe still, rectifying columns and re-boilers.

Condensation and Heat Exchange

Utilization of Heat from Uncondensed Vapors in Stills. Alekseyev.—(Azerbeidyansk. Neftyanoye. Khoz. 1927, *No.* 12, 40-8; *C. A., Vol. 22, No. 7, p.* 1232.) Alekseyev used a condenser of the type used for steam engines. He condensed vapors of lubricating oil, applying it at the same time as a heat exchanger for preheating crude oil. The uncondensed gases were pumped through the tubes under vacuum giving brighter lubricating oil. These heat exchangers are very compact and safe in operation. They could be cleaned and repaired better than the old type of spiral condensers and also are more efficient. The yield of finished or semi-finished product could be increased by 20-25 per cent. Alekseyev gives a complete description of the plant with drawings, calculations, etc.

Cracking

Investigations on the Chemistry of Cracking. Sakhanov and Tilichev. (Erdol u. Teer 4, 9-12, 43-5, (1928); *C. A., Vol. 22, No. 7, p.* 1230.) The specific gravity of the fraction above 300 degrees C. of a paraffin-rich oil increased with cracking time, whereas that of paraffin remained unchanged, indicating condensation at the expense of the aromatic hydrocarbons only. The same distillate, after removal of the aromatics with fuming sulfuric acid, was much lower in specific gravity and in asphaltic and carboid material after subsequent cracking than the untreated oil. The time required for maximum yield (30-35 per cent. each of benzine and kerosene, leaving a residue suitable for fuel oil) decreased from 45 hours at 375 degrees C., to 20 seconds at 500 degrees C., and decreased with increasing specific gravity of the fractions cracked. The coke-forming tendency is much less with paraffin-rich oils than with paraffin-free oils rich in resin, and increases with higher fractions. The benzine yield decreases above a certain optimum pressure. Olefins disappear with increasing pressure. Naphthenes in the cracked product evidently result only from naphthenes in the raw oil and not from olefins, as claimed by many authors. In reviewing the literature, it was brought out that, with naphthenes, splitting off of side chains and dehydrogenation occur. As with aromatics, instability increases with molecular weight, but only the six-carbon rings tend to dehydrogenation. The naphthenes left in cracked benzine are therefore mainly five-carbon nuclear. With the aromatics, condensation and splitting-off of side chains are characteristic.

Acid Treatment

Designing Equipment for Chemical Treatment of Oil Distillates. Morrell and Bergman.—(Chem. and Met. Eng., Vol. 35, *No.* 4, *pp.* 210-214.) Chemical treatment of oil distillates whether in batch or in continuous-treating equipment depends (1) upon efficient contact, that is, good mixing and sufficient time for reaction, between oil and reagent; (2) withdrawal of reaction products from treated oil. In batch treatment contact is obtained by air-blowing, by mixing with mechanical devices such as propellers upon a rotating shaft or by circulating devices such as centrifugal, gear or rotary pumps. Air-blowing results in relative large evaporation losses; therefore, mechanical mixing methods are preferable. In continuous-treating systems, each individual step or reagent in the treatment requires a mixing and settling element. Commonly-used

SEAMLESS STEEL STILL TUBES

Thousands of Babcock & Wilcox open hearth seamless steel still tubes are in service in refineries throughout the country.

These tubes have been supplied to various specifications, either with plain ends or upset as ordered.

Many of them are thirty feet long, made hot finished by a process perfected by this Company, for tubes of unusually long length.

The more common sizes are carried in stock at the Mill for immediate shipment.

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Figure No. 680

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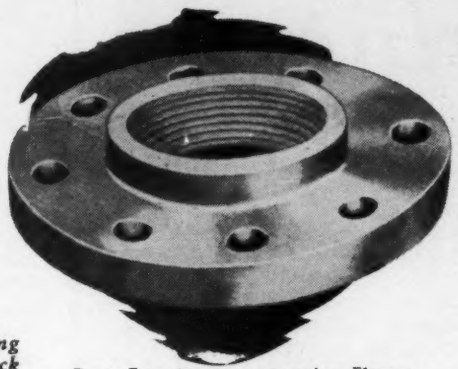

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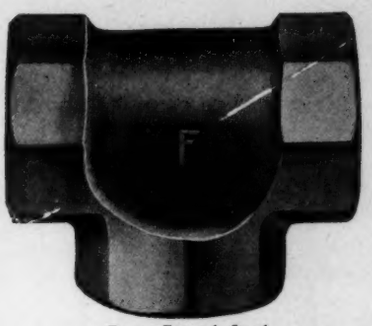

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The Refinery Supply Co.

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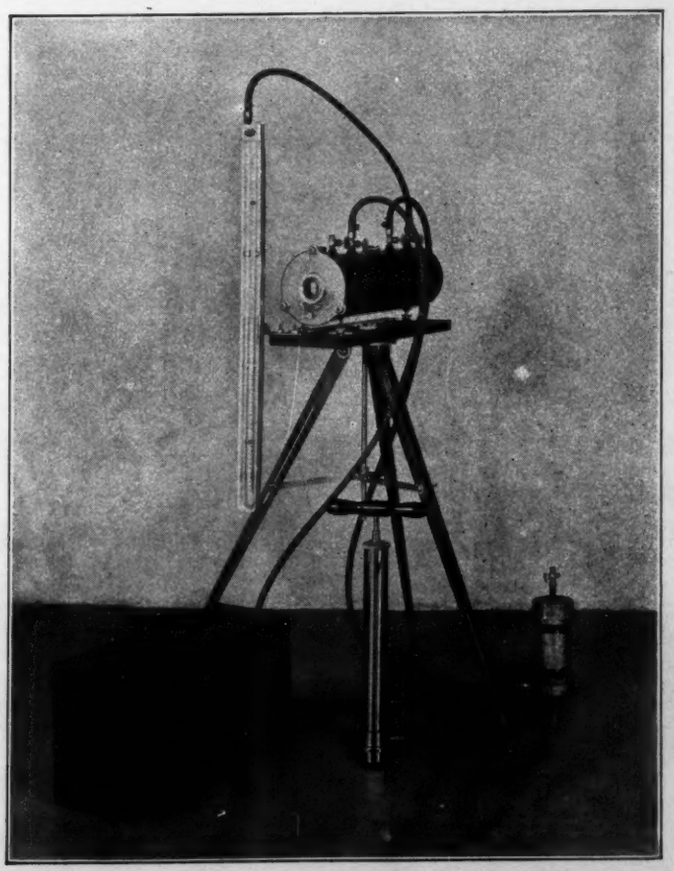
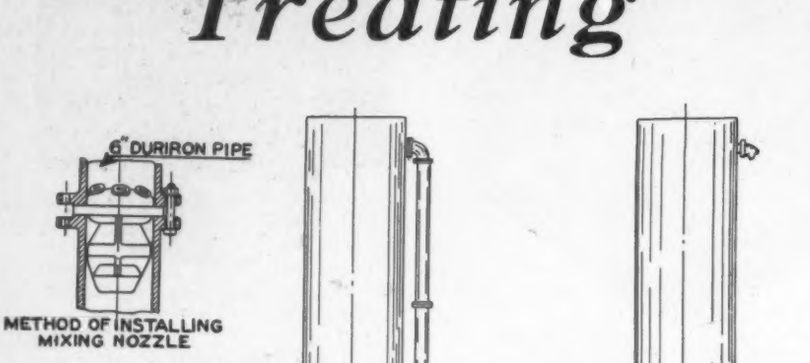


Low Cost of Treating



GREAT savings in time, power, chemicals and equipment are effected when Duriron acid-proof mixing nozzles are used for continuous treating of light oils with sulphuric acid or other treating agents. They are equally efficient for blending and making up of emulsions.

The salient features of the Duriron nozzle are complete immunity from corrosion and erosion; an intimate mixture of liquids of different specific gravities; elimination of excessive back pressure on the pumping system, and ready adaptability to any mixing process.

One Duriron mixing nozzle will eliminate six or more orifice plates.

Full Information Sent on Request.

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The Spiral Motion Is the Trick

That's why Hood's Chemico Spiral Packing Rings have been selected by so many engineers. The center hole prevents choking and clogging.

Made of acid-resisting shale—practically indestructible.

Used by all big producers because of the intensive movements.

Samples on request.

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mixing columns include orifice columns, packed columns, baffled columns or coils and mechanical mixing methods.

Description is given of several different types of mixers. Authors report orifice mixer as being highly satisfactory. In such a mixer intimate contact is obtained by pumping oil and reagent together in proper proportion through a series of orifice plates placed in the pipe. The superficial velocity of the liquid through the pipe should be quite low. For most efficient action per plate, a fairly high pressure drop should be allowed across the plates and the orifice area should be divided into several small holes rather than a large one. The energy of the high velocity jets is dissipated on the downstream side in eddies and turbulence, resulting in efficient mixing. In the design of an orifice column, the following formula is used:

Where

$Q = CA\sqrt{2GH}$

Q = Flow in cubic feet per second

C = Discharge coefficient = 0.65 (For oil distillate)

A = Area of orifice in square feet

G = Gravity of acceleration = 32.2 feet per second

H = Head of liquid in feet

Or

$Q_b = 18.26\ D^2\sqrt{H}$

Where

Q_b = Flow in barrels per hour

D = Diameter of orifice in inches

H = Head of liquid in feet.

Authors describe and illustrate with drawings the construction of an orifice column and state and solve two problems in the design of such a column for mixing sulfuric acid and oil; give hints on the design and illustrate with a drawing the details of construction of a baffle-plate mixing column; describe and comment upon packed mixing columns, and discuss jet and mechanical mixers.

Morrell and Bergman state that high-velocity rotary or centrifugal pumps for direct feed of oil or reagent or for recirculation of acid and caustic sludges and oils function as mixing devices, but should always be supplemented by other mixers. Efficient mixing with a pump can be obtained by pumping the distillate backward or by reversing the direction of rotation through a centrifugal pump that has had the impeller cut down to a small diameter. A similar scheme is to use a two-stage pump in which the second stage impeller has been cut down in diameter and reversed. To avoid losing suction with light, "gassy" distillates, pumps in the system should be placed low enough to maintain a head on the suction side. Oil-feed pumps may be of duplex-piston, centrifugal, gear or rotary types. Rotary pumps maintain a uniform discharge pressure. Pumps should be fitted with good stuffing-boxes to avoid leakage of light distillates. For a direct-acting steam-pump of the duplex type, a speed governor or pressure governor should be used to maintain a uniform flow. All motor-driven pumps should have the motor and starting switch in a separate closed room to prevent the possibility of a spark ignit-

ing the vapors. The pump should either be fitted with acid-resisting bronze or be made of cast-iron.

Continuous treatment of Kerosene Distillate. Selsku.—(Azerbeidyansk. Neftyanoye Khoz. 1927, *No.* 12, 53-8; *C. A., Vol. 22, No. 7, p.* 1231.) Selsku found that the time required for treatment of oil with the reagent could be very short, providing sufficient of the reagent is in contact with the oil and the mixing of both is thorough. An equipment for treatment has been designed which is working on a counter-current principle. The treatment is continuous and consists of three units. The oil is admitted or atomized in the first unit through a nozzle with small bore or a pipe with a spiral giving the oil a rotating movement, just exposing a large surface of oil to the acid. The oil is passed under pressure through three similar units and is withdrawn from the top unit. The acid enters the top unit and is kept in the same as long as advisable. The units have the appearance of oblong closed boxes having a funnel on the end of the bottom where the oil is admitted and a vent on the other end which can be opened only in one direction by compressed air to let the acid (or sludge, if any) out to the next unit, where it again comes in contact with oil. The same operation is required for the second unit to supply the first unit with acid. The fresh acid is let in the third unit through the cover. Measurements and drawings are given.

Application of Ejector-Mixers for Treating Oil. Kostrin. — (Neftyanoe Khozyaistvo, 13, 459-65 (1927); *C. A., Vol. 22, No. 8, p.* 1466.) Ejectors similar to those used for steam boilers have the following advantages for the acid and alkali treatment of petroleum products. Air used for mixing the reagent and oil in the old equipment is entirely eliminated. This produces a brighter kerosene and makes the loss through evaporation and oxidation by air negligible. The treatment or contact of oil and reagent takes place in the ejector, eliminating the usual equipment. Comparatively small settling tanks are required. As air and moisture are avoided, the acid is kept more concentrated and active. The formation of heavy emulsions in treatment with caustic is avoided by using 4 degree Baume caustic solution at a temperature of 35 to 40 degrees C. The consumption of caustic is 0.12 to 0.14 per cent. against 0.13 to 0.15 per cent. Full description of plant with drawings is given.

Vapor-Phase Clay Treatment

Vapor-Phase Treatment of Light Oils from the Pyrolysis of Kerosene Distillate with Fuller's Earth. Guerr and Popov.—(Azerbeidj. Neft. Khoz. 1927, *No.* 8-9, 80-4, *C. A., Vol.* 22, *No.* 6, *p.* 1033.) Cracked kerosene distillate from Surakhanui fuel oil had a density at 15 degrees C. of 0.840 to 0.850, color light to dark yellow, Engler distillation: initial boiling point 62 degrees, 27 per cent—100 degrees; 65 per cent—125 degrees; 79 per cent—150 degrees; 90 per cent—170 degrees. The vapors passed through a column filled

One of our spray nozzle cooling systems in operation at an oil refinery in Louisiana

An Investment Problem

IF YOU need water cooling equipment at your plant, your problem is not merely one of buying equipment. Instead, it is a problem in investment—how to get the greatest return per dollar expended.

If you invest your money in one of our cooling towers or spray nozzle systems, we guarantee to give you the maximum return on your expenditure. We have made installations in plants where the available funds were limited, and also in plants requiring all the refinements necessary to secure the maximum operating economies. In every case we worked closely with their engineers in designing and adapting our standard equipment to meet their peculiar requirements.

A letter to our nearest office will bring to see you an engineer of experience, a man who is interested in helping you with your water cooling problem, a man who will consider that problem as one in investment in plant equipment.

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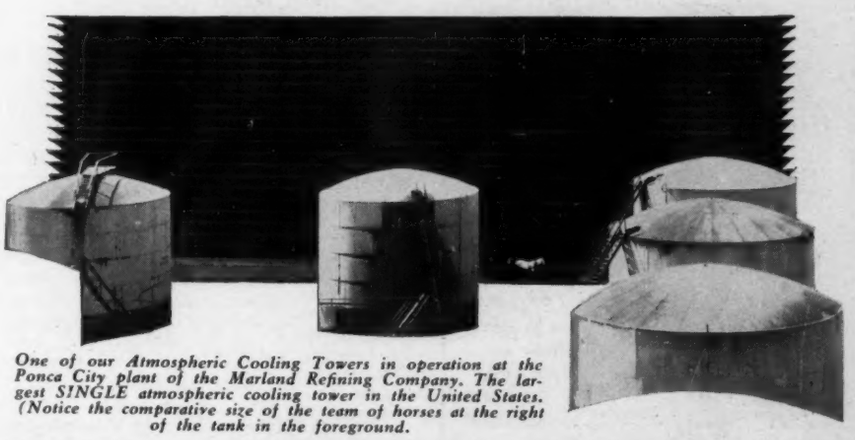

One of our Atmospheric Cooling Towers in operation at the Ponca City plant of the Marland Refining Company. The largest SINGLE atmospheric cooling tower in the United States. (Notice the comparative size of the team of horses at the right of the tank in the foreground.

Chemical Engineer

For position of Chief Technologist in charge of research and experimental department of large oil refinery in Chicago district. Must have minimum six years experience in oil refinery including thorough knowledge of topping, cracking, lubricating, treating, physical chemistry and fractionation. Prefer applicant to have Ph.D. from American or foreign university. Give complete resume of education, experience, general qualifications, references, age, salary expected, also send small photograph. All negotiations strictly confidential. Address reply to Box No. 1928, care of Refiner and Natural Gasoline Manufacturer.

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Steam to Oil Stills,

you can

Control it, Watch it *and* **Record it**

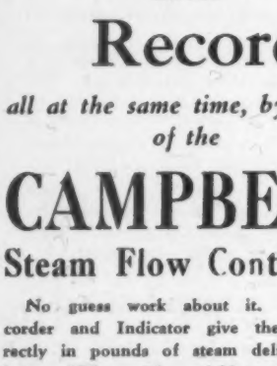
all at the same time, by means of the

CAMPBELL

Steam Flow Controller

No guess work about it. The Recorder and Indicator give the rate directly in pounds of steam delivered per hour, which may be quickly varied as the operator desires.

Two types, "Watermelon" and "Pumpkinseed," as shown in our ad in the February issue. Ordinary meters *record* only; the Campbell *controls, indicates and records*, all at the desired rate. We invite inquiries also on fluid level control — *i.* e., condensation or vapor reliefs, etc. Write us fully in regard to your problems.



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with chipped glass tubing, porcelain and fuller's earth. The fuller's earth was heated for one hour at 300 degrees C. before each distillation. The column was electrically heated up to 300 degrees C. depending on fractions. The average distillation yielded 94.4 per cent. of colorless oil, density at 15 degrees C. of 0.841; 2.7 per cent. held by fuller's earth; 2.3 per cent. residue; 0.6 per cent. loss; Engler distillation: initial boiling point 73 degrees, 34 per cent—100 degrees; 68 per cent—125 degrees; 86 per cent—150 degrees; 92.5 per cent—170 degrees. A Russian product, "Glukhovskii" clay was tried with similar results. The oil adsorbed by fuller's earth was extracted with a mixture of benzene and ethyl alcohol (8:1 by weight). The same treated fuller's earth was used three times without any deterioration. This process is much cheaper than the customary acid-alkali treatment, giving a yield of over 90 per cent. against 79-80 per cent by the old method.

Refrigeration

Automatic Ammonia Control Valves. Veneman. (*Power, Vol.* 67, *No.* 4, *Jan.* 24,1928, pp. 148-151). Discusses shortcomings of existing automatic control valves and outlines plant conditions that influence operation of such expansion valves. There are four types of automatic control valves in common use: stop valves, to open and close quickly; constant-pressure valves, to maintain definite suction pressure; constant liquid-level valves, to keep liquid in evaporators at definite level; and load-demand valves, to control liquid supply in proportion to load demands upon evaporator.

* * *

A New Simple Process for Producing Very Low Temperatures. Simon. (*Zeit. fuer die gesamte Kaelte-Industrie, Vol.* 34, *No.* 12, *Dec.* 1927, *pp.* 217-221. *Mech. Eng. Vol.* 50, *No.* 5, *p.* 429.) Reports experiments made in institute for physics and chemistry of the University of Berlin on cooling by means of reversing process of gas adsorption. Proposes to use zeolites, such as chabasite, as adsorbents.

OF PARTICULAR INTEREST TO REFINERY AND CHEMICAL ENGINEERING

Heat Flow and Heat Transfer

Measurement of Heat Folw. Dutton. (*Jour. Sci. Inst., Nov.* 1927. *Chal. et, ind., March,* 1928, *p.* 156. *Libr. Bull., U. O. P. Co., Vol.* 3, *No.* 16). Hitherto two methods have been employed in measuring the flow of heat through materials. Barker's method consists in measuring off 10 square feet on the wall surface and covering this area with a heat-insulated box. The quantity of heat necessary to maintain the temperature of the air in the box at the same point as the air in the chamber is measured. In Nichol's method the flow of heat is deduced from the temperatures in a layer of material applied upon four square feet of the wall. By the new method described a square foot of the wall is covered with a plate heated electrically and covered with cork; and the quantity of heat necessary to hold the surface under the plate at the same temperature as the exposed surface is measured.

* * *

Heat Transfer in Oils Flowing Through Pipes. Garcia. (*Presented at the Spring Meeting of A. C. S., St. Louis, Mo., April* 16-20, 1928). The equations generally used to determine mean temperature differences and heat transfer coefficients in heat exchange equipment are based on the assumptions of constant specific heat and constant heat transfer coefficient throughout the temperature range. Those factors however vary with the liquid temperature and, in the case of petroleum oils, the variation is sometimes so considerable as to make the use of the mean temperature difference wholly unjustified on theoretical grounds. Differential equations were derived by Garcia for heat transfer in viscous liquids, taking into account the change in physical properties of the liquid with temperature. Graphical integration of these equations give true mean liquid temperatures, from which mean temperature differences and heat transfer coefficients may then be calculated. Mean liquid temperatures obtained by this method differ considerably from those given by the logarithmic mean formula and show a totally different law of temperature distribution along the exchanger. Graphical methods are given for the calculation of mean liquid temperatures, to be used for the correlation of experimental data or the design of exchangers for viscous oils involving large temperature ranges.

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Boiler Plant Construction and Operation

The Characteristics of Modern Boilers. Fish. (*Machy. Market, No.* 1419, *Jan.* 13, 1928, *pp.* 21-22). Changes in shape and design due to use of higher pressures; more powerful fabricating equipment and greater care in methods of workmanship; modern size, moderate-pressure boilers in majority, furnace improvements; modern fuel-burning apparatus designed to use small amount of excess air; water walls must be carefully and properly designed and arranged; draft problems; details of boiler design considerably modified to accommodate superheaters sufficiently large to give desired temperatures; furnace-controlling systems.

* * *

Heat Transmission Through Boiler Tubes. Croft. (*Bulletin of Univ. of Ill., Vol.* 25, *No.* 5, *Oct.* 4, 1927.) Investigation to obtain heat transmission data under conditions similar to those existing in actual water-tube boiler and to study phenomena of water circulation under same conditions; conclusions drawn are that coefficient of heat transmission of apparatus is affected by: rate of gas flow; temperature difference between flue gas and water; pressure at which steam is generated; temperature of gas stream; water velocity in tube has slight effect on overall coefficient of heat transmission.

* * *

The Reflux Ordinate Boiler-Efficiency Diagram. (*Power Engr., Vol* 23, *No.* 262, *Jan.*, 1928). Presents diagram on supplementary plate based on Callendar's enlarged steam tables; drawn and designed by H. C. Golder and R. B. Page.

* * *

Feedwater Control Equipment. (*Power Plant Eng., Vol.* 32, *No.* 2, *Jan.* 15, 1928, *pp.* 117-120). Present-day demands require quicker response from feedwater regulators; types of regulators, their application and operation.

* * *

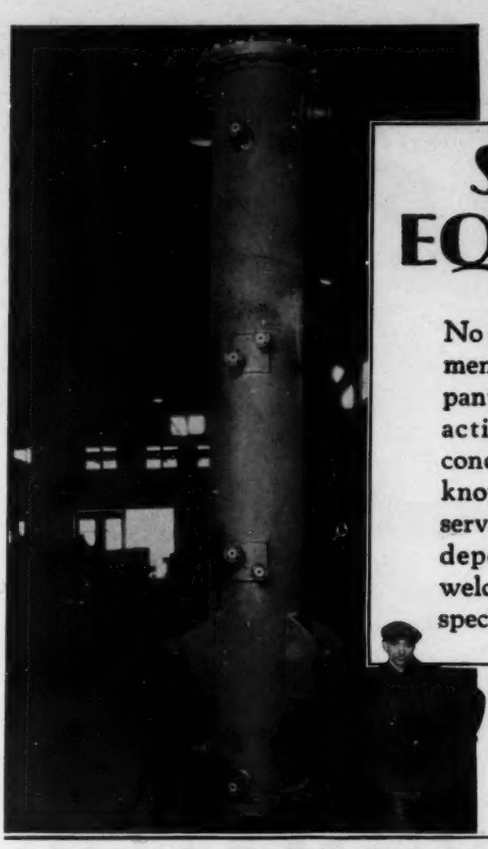
Sodium Aluminate as an Aid to Water Softening. (*Am. Ry. Eng. Assn. Bull., Vol.* 29, *No.* 300, *Oct.* 1927, *pp.* 138-142). Use of sodium aluminate in water softening; table showing additional savings resulting from use of sodium aluminate in lime and soda plants.

OF PARTICULAR INTEREST TO THE CHEMIST

Testing and Analysis

The Estimation of Nitrogen in Petroleum and Bitumens

(*Poth, Armstrong, Gogburn and Baiby. Ind. and Eng. Chem., Vol.* 20, *No.* 1, *pp.* 83-85). Suggestions of procedure are offered for the estimation of nitrogen in petroleum products and bitumens by the Dumas and Kjeldahl methods. The analytical data presented make it doubtful whether any California petroleum contains as much as 1 per cent nitrogen or any Texas Gulf Coastal oil as much as 0.1 per cent. nitrogen. Analyses show certain Mexican, Venezuelan and Colombian petroleums to approach California crudes in their abnormally high nitrogen content. Proof is furnished that (1) the nitrogen compounds in crude petroleum are not al-



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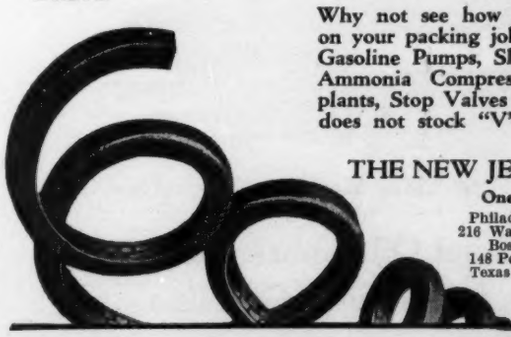

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ways in basic form, and (2) chemical changes occur in the nitrogen compounds on distillation of petroleum.

* * *

Control of Lubricating Oil Refining. Grunewald. (*Petroleum Z.*, 23, 1621-2 (1927); *C. A. Vol. 22, No.* 8, *p.* 1466). A method for color comparison of oils is described in which the standards have been made by blending a highly refined with a poorly refined oil.

* * *

The Volumetric Estimation of Sulfur in Crude Oils by Modified Nikaido Method. Woodward. (*Presented at St. Louis Meeting A. C. S., April* 16-20, 1928. *Libr. Bull., U. O. P. Co., Vol* 3, *No.* 17). The method is the titration of sulfate ion with lead using potassium iodide as indicator.

Enough oil is burned in a bomb to give 0.03 to 0.20 gm. sulfuric acid. The products of combustion are washed into a beaker and a uniform amount of potassium iodide added. Aluminum powder is introduce to precipitate iron. The mixture is concentrated to less than 50 c.c., and more aluminum added if the solution is not colorless. The beaker is cooled, the contents washed into a 300 c.c. Erlenmeyer flask, and made up to 50 c.c. Alcohol is added so that a 50-70 per cent. solution results, and standard N/5 lead nitrate added to a yellow color. The method is standardized with N/10 sulfuric acid.

* * *

Rapid Method for Testing the Tendency of Transformer Oils to Form Sludge. Matthis. (*Chimie et industrie* 19, 62-3 (1928); *C. A., Vol. 22, No.* 8, *p.* 1467). Formation of sludge in transformer oils is due to fixation of atmospheric oxygen under the action of heat, time of heating and polymerization. The method proposed consists essentially in heating 40 c.c. of oil in a beaker 50 mm. in diameter by 37 mm. high (the volume of oil taken may be varied, provided the ratio of volume to oxidizing surface is kept constant) to increasingly severe oxidizing conditions, and noting when sludge appears; e.g., heat five hours at 170 degrees C., then 10 hours at 200 degrees C., etc., till sludge appears, and note the time. An experienced observer can detect the presence of 0.001 per cent. asphalt. Many years experience with the test has shown that the useful life of the oil in service increases with the time required for sludge to appear.

Research and Investigational Work

The Oxidation of Steam Turbine Oils. Butkov. (*Erdol u. Teer,* 3, 823-4 (1927). *C. A., Vol. 22, No.* 5, *p.* 862). Highly refined oils (that is, by fuming H_2SO_4) oxidizes more rapidly in use than less refined oils, although they are superior in other respects, notably in not forming sludge. This susceptibility to oxidation is believed to be due to the removal of anti-oxidants in refining. It can not be judged by the usual oxidation tests, etc., but can be judged by Butkov's method, namely, heating with oxygen (O_2) under 15 atmospheres at 150 degrees C. for four hours.

REFINERY AND GASOLINE PLANT ACTIVITIES

New Plants – Construction Notes – Personel Changes

COMPLETING BIG PLANT

Los Angeles,—The gasoline absorption plant of the Shell Oil Company of California, one of the largest on the West Coast, was due to be completed in May. It consists of two complete distillation units, power plant, water cooling tower, piping and accessory apparatus. Southwestern Engineering Corporation constructed the plant and furnished the equipment.

San Francisco. — The Berry Oil Company of this city has begun operating its new gasoline plant at Belridge, Kern County. The Southwestern Engineering Corporation constructed the plant and installed the compressor plant and cooling tower.

Washington. — A bill by Representative Howard, democrat, of Tulsa, Okla., would authorize an appropriation of $25,000 for the maintenance of the United States Bureau of Mines Petroleum Experiment Station at Battlesville, Okla., in addition to the amount already appropriated by Congress for the Bureau of Mines. The bill has been referred to the Committee on Mines and Mining.

Los Angeles.—Through acquisition of the California Petroleum Corporation, the Texas Corporation also obtained a subsidiary company, the California Gasoline Company, one of the largest manufacturers of natural gasoline on the West Coast. Properties of the California Gasoline Company include 12 operating plants, scattered in several fields of the Los Angeles basin, their combined capacity being about 200,000 gallons daily. The largest of the 12 plants is at Signal Hill; it has a daily capacity of 60,000 gallons.

TO OPERATE PORTABLE PLANT

Midland, Texas.—The 2,500-barrel daily capacity portable type skimming plant formerly operated in the Wortham field, Texas, by the Peerless Refining Company, Dallas, has been leased by the Midland Refining Company to operate on West Texas crudes at Midland. This plant has been moved on its own trucks via railroad from Wortham to Midland, and will begin operating June 15. This is the first of three portable type of plants manufactured by the Graver Corporation, Chicago.

The Midland Refining Company was organized in May under the laws of Texas, with a capital stock of $20,000, with the following officers: T. W. Sowell, Dallas, president; V. E. Jackson, formerly sales manager of the Texoma Oil & Refining Company and the Iowa Park Producing & Refining Company, vice-president and in charge of sales. H. Englehardt, who had charge of the portable plant at Wortham, will be superintendent.

The Midland plant has contracted to sell 150,000 barrels of fuel oil to the Texas & Pacific Railroad, and will market most of its gasoline and kerosene production in and around Midland on trucks. The company is protected on its crude supply for 12 months through a contract made with the Atlantic Oil Producing Company at a flat price. This crude contract calls for a minimum of 1,000 barrels and a maximum of 2,000 barrels daily, and the oil is to be delivered from the Hendrick field direct to the plant via the Atlantic Pipe Line Company's line.

CHEMICAL MEETING

New York.—At a joint meeting of the chemical societies here the early part of May, Dr. P. K. Frolich of M. I. T. pointed out the possibilities for creation of various entirely new organic chemical industries based on high pressure syntheses using carbon monoxide and similar low priced raw materials. He said that research work during the past few years has demonstrated the possibility of synthesizing practically any aliphatic organic compound by the catalytic conversion at high pressure of carbon monoxide and hydrogen. It is possible by that means to produce pure methanol, ethyl, butyl, propyl, and amyl alcohols, by variation of the catalysts used.

BUILDING ASPHALT PLANT

El Dorado, Ark.—The Union Asphalt Company, with headquarters in the Exchange building, El Dorado, Arkansas, has started construction of an asphalt plant adjacent to the El Dorado refinery of the Lion Oil Refining Company. The former concern has obtained a five-year contract for the residium output of the Lion plant, and will manufacture asphalt fluxes and various road oils under a Unasco trademark. The first unit of the asphalt plant will be equipped with one pipe still and two kettles, with a capacity of 150 tons daily, and the residium from the Lion plant will be delivered at temperatures ranging from 450 to 600 degrees F.

The officials of the Union Asphalt Company are: J. B. Sowell, Dallas, president; J. K. Mahoney, vice-president; Herbert Williford, secretary-treasurer; and H. T. Miller, plant superintendent.

CORPUS CHRISTI BUNKERS

Corpus Christi, Texas.—George B. Eggleston & Company, with headquarters in the Central Trust building, San Antonio, is constructing a bunker oil terminal at Corpus Christi, and will erect steel storage for the accommodation of about 150,000 barrels of fuel oil. The company will obtain most of its bunker oil from Mexico, and will also handle road oils. The station is scheduled to be in operation by July 1, 1928.

GRAVER OFFICIALS COMBINED

Fort Worth, Texas.—The refinery equipment sales division of the Graver Corporation in the Mid-Continent district will be transferred from Tulsa to the Petroleum building, Fort Worth, as result of the forthcoming resignation of H. E. Clark, who has accepted a position as sales manager for the refinery being erected at Laredo, Texas, by the Motor Fuel Products Company. C. L. Marner, who has had charge of the Tulsa office for Graver, will move to Fort Worth June 15, and will then have charge of all refinery equipment sales in the Southwest.

INCREASE CAPACITY

Los Angeles.—Installation of absorbers at the Long Beach plant of the Shell Company was recently completed by J. A. Campbell. With the additional equipment, the plant will have facilities for handling 60,000,000 cubic feet of gas daily, or about 180,000 gallons of natural gasoline a day.

OREGON BASIN CRUDE SOLD AT 53 CENTS

Denver.—The Cody Petroleum Company will sell its Oregon Basin crude at 53 cents per barrel, shipping it through the Illinois Pipe Line Company's line to Cody and then by rail to the International Refining Company's plant at Sunburst, Montana. The contract for the sale of this oil is subject to the approval of the Department of the Interior. The International plant has a charging capacity of 8000 barrels a day. It is owned by the California Petroleum Company, which is now controlled by The Texas Corporation.

Tulsa.—Comer Plummer has been named vice-president and general manager of the southwest division of the Pure Oil Company, succeeding the late Howard N. Cole.

PAMPA PLANT OPERATING

Pampa, Texas.—The Pampa Refining Company has completed construction work on its 2,000-barrel daily capacity skimming plant, located at Pampa, and began operating about June 1. This plant is owned by Reese S. Allen and A. McClory, Wichita Falls, and G. L. Rowsey, Amarillo, and is supplied with crude from the Bowers-Jackson pool, Gray County section of the Texas Panhandle, via the Toronto Pipe Line Company. Rowsey is superintendent in charge of the Amarillo Refining Company's plant at Amarillo, and perfected a process for the handling of sulphur contaminated crudes produced in the Panhandle, in the Amarillo plant that commanded considerable attention when Mid-Continent plants began operating on Panhandle oil.

SWEETWATER COMPANY RE-ORGANIZED

Sweetwater, Texas. — Re-organization of the Sweetwater Refining Company, which has been operating a small skimming plant at Sweetwater on West Texas crudes delivered in tank cars, was completed May 5, and in the future operations will be conducted under the name of Sweetwater Oil & Refining Company, which was incorporated by W. V. Thraves, M. E. Coley and J. C. McClure. C. H. and J. R. Travis of Duncan, Oklahoma, are the principal owners of the new concern, and J. A. Johnson, formerly of Tulsa, has charge of plant operations. The plant has been handling about 200 barrels of crude daily, but will be increased in capaciay.

CARBON BLACK EXPORTS

Export business in carbon black is materially increasing, as indicated by the fact that during the first two months of 1927 the outgoing shipments amounted to 7,566,919 pounds, while during the corresponding months this year they aggregated 13,451,469 pounds.

The Panhandle district of Texas is rapidly increasing its production of carbon black, and by the end of this year will have over a dozen plants. During 1927 Texas produced 20,174,409 pounds of carbon black, but is expected to produce 75,000,000 pounds the present year, a large proportion of which will be turned out in the Panhandle district.

BUILD PLANT IN TEXAS

Chicago. — W. D. Richardson, formerly head of the Meridian Petroleum Refining Corporation of Kansas City, has announced plans for the construction of a refinery at Sweetwater, Texas, and expects the plant to be in operation by November. It will operate on crude secured by pipe line from Howard County, and will have a daily capacity of 5,000 barrels. J. S. Cosden, who has oil properties in Howard County, will build the pipe line, it is reported.

BUILDING TWO PLANTS

Los Angeles.—The Dabney-Gilmore Oil Company has started construction of an oil absorption plant at Signal Hill, and expects to have it in operation in July. It will have a capacity of 30,000 gallons daily. The company also will begin construction early in June of a plant similar in size to the Signal Hill plant in the northwest extension of the Long Beach field. The Dabney-Gilmore company is owned by the Gilmore Oil Company and Joseph B. Dabney. The new Signal Hill plant will operate on gas from wells which Mr. Dabney owns in that fields.

NEW PLANT STARTS

Breckenridge, Texas. — The Ward Gasoline Company of this place expected to have its new gasoline plant in operation by the first of June. The plant is northwest of Breckenridge. Its capacity will be around 5,000,000 cubic feet of gas a day, and will operate on gas from the leases of Pace & Ward, selling the residue gas to the Texas Carbon Industries.

for Southwestern Refiners

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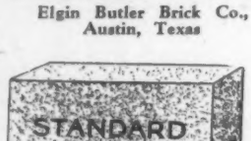

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SNOWCAP REFINING COMPANY

Great Falls, Mont.—Snowcap Refining Company officials have announced the company's intention of building a refinery at Collins when the production of the Bannatyne field shall have reached 500 barrels per day. The Genou Pipe Line Company has already announced its plan for a pipeline from the field to Collins.

At present the production of the field is an estimated 175 barrels per day. The new plant will be arranged so that additional units may be added to it as the field's output increases. A. J. Eulberg, president of the refining company, states that the Bannatyne oil shows a gasoline content from one to two per cent. less than Kevin-Sunburst crude, and the percentage of sulphur is substantially smaller .

Los Angeles.—A large consignment of tank vapor controls manufactured by J. A. Campbell, natural gasoline engineer, is being installed at the Athens Tank Farm of the General Petroleum Corporation. The controls will take care of the vapors as fast as generated and will admit dry gas in case of vacuum caused by cooling or emptying.

F. L. Martin has accepted a position in the sales department of the Transcontinental Oil Company here. He was formerly sales manager of the White Oak Refining Company, Tulsa, and previous to acceptance of that position was manager of that company's refinery in Allen, Oklahoma.

K. W. Shimeall is now superintendent of the Sapulpa, Oklahoma, refinery of the Continental Oil Company, succeeding M. S. Beringer, who will represent an American refinery equipment manufacturer in Roumania. Mr. Shimeall was formerly superintendent of the Glenrock, Wyoming, refinery of the Continental.

E. W. Nick, president of the Northern Equipment Company, Erie, Pennsylvania, has returned to America after an absence of several months in Europe. Mr. Nick visited the various European factories where Copes boiler feed water regulators are made, and also visited the Copes representatives in practically all of the countries of Western Europe.

Sweetwater, Texas. — Management of the skimming plant of the Sweetwater Refining Company here has been taken over by J. A. Johnson of Tulsa, the property having been purchased from C. H. Travis and J. R. Travis by several Oklahoma and Kentucky operators whose names have not been announced. The capacity of the plant will be increased to 1500 barrels daily. Its products will continue to be marketed under the same trade name, White Lily gasoline and motor oils.

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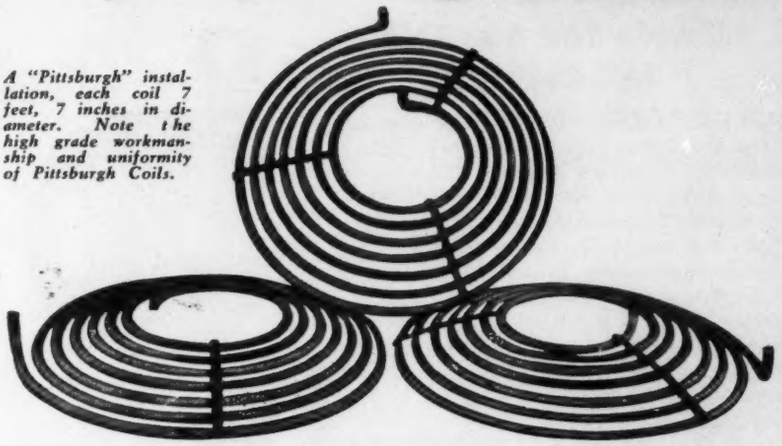

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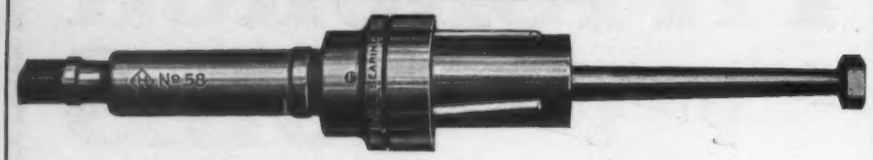

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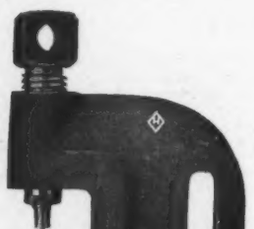

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Herbert Wolcott, 207 San Francisco St., El Paso, Texas.

REFINERS MERGE

Toledo, Ohio. — Hickok Producing Company, and the Great Lakes Refining Company, both of Toledo, recently merged, forming a new organization which will operate the plants under the name of Hickok Producing & Refining Company. The newly organized company has a refining capacity of approximately 3,000 barrels daily, and it plans to double this capacity at once by the installation of new units and additional equipment.

Toledo now is the leading refining city in Ohio, having five major plants and several smaller refineries. Standard Oil Company of Ohio; Craig Refining Company, Sun Oil Company, Paragon Refining Company and the Hickok Producing & Refining Company all operate plants at this point.

When it purchased the plant of the Great Lakes Refining Company at Toledo, the Hickok Producing Company also acquired rights to use the Gyro vapor phase cracking process. Hickok will enlarge and rebuild the newly acquired refinery, making its daily capacity 6000 barrels. The company has considerable production in North Texas. A subsidiary company, the Hickok Refining Company, has been organized to operate the new branch of the business.

DUTCH WEST INDIES

The Pan American Petroleum & Transport Company, subsidiary of the Standard Oil Company of Indiana, has started construction of a refinery on the island of Arubia, Dutch West Indies, to be operated on Venezuela crude.

DUBBS UNIT IN ITALY

Chicago.—The Societa Anomina Benzina Italiana are installing one 1000-barrel Dubbs Cracking Unit in the refinery which they are constructing near Naples, Italy.

Los Angeles.—J. A. Campbell was recently awarded a contract for the addition of a new unit to the natural gasoline plant of the Bankline Oil Company at Long Beach. The additional unit will about double the capacity of the plant, increasing it to 50,000 gallons daily.

Los Angeles. — The Republic Supply Company of California has purchased the Associated Supply Company from the Youngstown Sheet & Tube Company, the purchase price, according to unconfirmed rumor, having been $2,000,000. The Associated Supply Company was formerly owned by the Associated Oil Company, and soon after the latter was bought by the Tidewater was sold to the Youngstown company.

Motor Fuel Theme of Natural Gasoline Convention

(Continued from page 77)

year: The Palmer Corporation, the Virginian Oil & Gasoline Company and the Standard Oil Company of California.

The following were members last year and chosen for the next year: Phillips Petroleum Company, Amerada Petroleum Corporation, Skelly Oil Company, Burrell Oil & Gasoline Company, F. C. Henderson Gasoline Company, Eagle Pitcher Lead Company, Carbide & Carbon Chemicals Corporation, California Gasoline Company, and the Sinclair Oil & Gas Company.

The holdover members are Empire Gasoline Company, Lone Star Gas Company, Chestnut & Smith Corporation, Prairie Oil & Gas Company, Oklahoma Gasoline Plants, Inc., Shaffer Oil & Refining Company, Roeser & Pendleton, Inc., Barnsdall Refining Company, Marland Refining Company and L. H. Wentz, Inc.

SAFETY WORK CONTINUES

Tulsa.—The work of the safety division of the Mid-Continent Oil & Gas Association will be continued under the direction of D. J. Wallace; and a larger appropriation has been made for the safety work. A special committee of the association found that 85 per cent. of the members of the organization do not maintain safety organizations of their own, and that only about a dozen companies have special safety men in charge of definite safety programs for educating employees. The committee recommended that foremen's meetings be held quarterly in every district in the Mid-Continent, and that more safety motion pictures be prepared and exhibited.

Los Angeles. — Morgan Washburn, Jr., has been appointed southern California representative of Wm. W. Nugent & Company, and will have his headquarters here at 1855 Industrial Street. Ford & Geirrine have been selected as Northern California representatives of the same concern, their headquarters being at 1006 Balfour Building, San Francisco. Wm. W. Nugent & Company are Chicago manufacturers, their products including oil filters, oil pumps, removable glass sight feed valves.

R. B. High, superintendent of the Arkansas City, Kan., refinery of the Roxana Petroleum Corporation, has been promoted to the superintendency of the enlarged Wood River, Ill., refinery of the company. He will be succeeded in the Arkansas City plant by P. E. Foster, assistant superintendent.

Oil City, Penn.—The Burrell-Mase Engineering Company of Pittsburgh is building a tail gas recovery system at the refinery of the Pennzoil Company here; and are installing several of their gasoline absorbers at natural gasoline plants.

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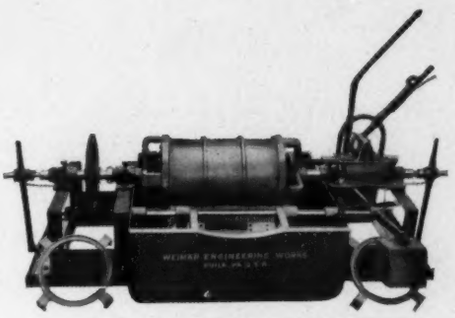

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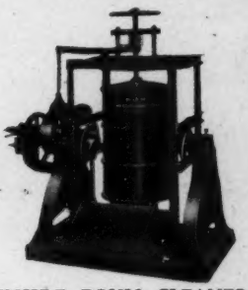

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